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ON THE MINIMUM SUFFICIENT SAMPLE SIZE FOR THE GROWTH STUDIES OF FISH POPULATIONS

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Abstract. Minimum sufficient samples size for growth studies of virtual populations of fish under three accuracy levels are discussed in this paper. Values of minimum sufficient samples at different age groups at the roach *(Rutilus rutilus)* from 2nd to 5th age group, the perch *(Perca fluviatilis)* from 2nd to 5th age group, the ruffe *(Gymnocephalus cernuus)* from 1st to 4th age group and the pike *(Esox lucius)* from 3rd and 4th age groups together, are given.

INTRODUCTION

In growth studies of fish populations, the size of the minimum representative samples is of great importance. First, according to the sufficient material of a particular species the size of the sample can be defined and used as a starting point in further research, second, it is possible to check retrospectively if the material studied for a certain work has been sufficient as regards its size. The problem of the minimal sample, elaborated satisfactorily in statistics, has been also solved in concrete examples. In fish populations, this problem has been tackled by Mišík (1962) for the bream *(Abramis brama)*, by Libosvárský (1968) for the brown trout *(Salmo trutta m. fario)* and Wohlgemuth (1984) for the bleak *(Alburnus alburnus)*. The determination of the minimum sufficient sample has also been dealt in some batrachological, ornithological and mammaliological papers, e.g. Davison (1940), Korschgen (1948), Hanson and Graybill (1956), Kratochvíl et al (1959), Sládek (1975), Obrtel and Holišová (1977), Roth and Rab (1987).

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MATERIAL AND METHODS

For the analysis proper, four fish species have been selected representing the size composition of our ichthyofauna. Most of material of fishes under study was obtained by the use of nets in the Slapy reservoir (Central Bohemia) during 1985 - 87. The number of individuals in separated age groups was as follows: the roach (2nd AG 459 sp., 3rd AG 381 sp., 4th AG 260 sp., 5th AG 219 sp.), the perch (2nd AG 379 sp., 3rd AG 273 sp., 4th AG 182 sp., 5th AG 74 sp.), the ruffe (1st AG 220 sp., 2nd AG 268 sp., 3rd AG 508 sp., 4th AG 193 sp.). Besides the sample of the pike (3rd AG 97 sp., 4th AG 58 sp). angled in rivers Vltava and Berounka (Central Bohemia) during 1953 - 88 was also used to this study.

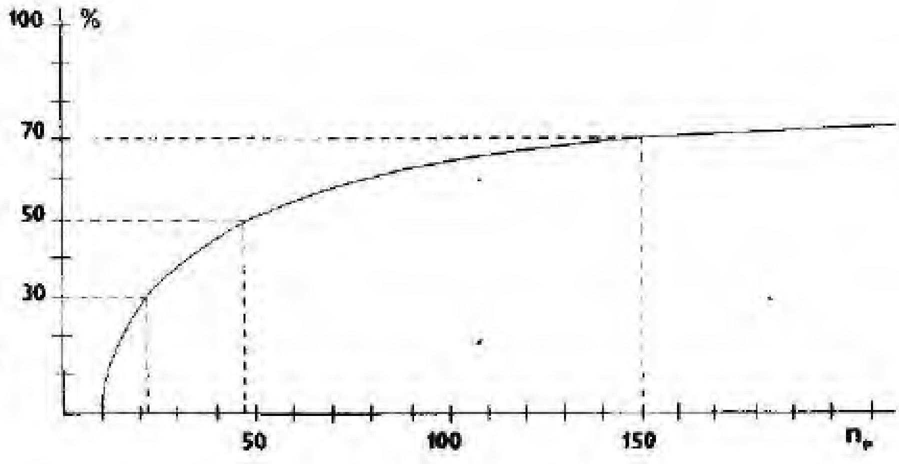

Fig. 1. Illustration of lowering of standard error of the mean ($s_{\bar{x}(10)}$) depended on increasing of randomly selected samples (n_p) at the perch, 4.AG ($s_{\bar{x}(10)}$ = 4.27, $s_{\bar{x}(22)}$ = 3.01, $s_{\bar{x}(47)}$ = 2.14, $s_{\bar{x}(150)}$ = 1.28. Abscissa - number of randomly selected specimens, ordinate - the change of $s_{\bar{x}}$ in per cent of the value $s_{\bar{x}(10)}$.

To specify the minimum sample of the population, the characteristic used was the body length of the fish (see Table 1). In Table 2, an example of the decrease of the value $s_{\bar{x}}$ (standard error of the mean) parallel with the increase in the size of a randomly selected sample is shown, represented by the roach of the age 2nd AG. From the values n_p and $s_{\bar{x}}$ obtained (see Table 3), an exponential equation was calculated. The same procedure was applied in the case of all the kinds studied and their individual age groups (see Table 3). An example of the curve obtained (perch of the age 4th AG) is shown in the graph. Here also the method of reading off the size of the minimum sufficient sample is evident. The value $s_{\bar{x}(10)}$, corresponding to a randomly selected sample of 10 individuals, was taken as the base. Furthermore, the size of the minimum sample was read from the graph, corresponding to the decrease of the value $s_{\bar{x}(10)}$ by 30, 50 and 70 per cent (see Table 4). With regard to the fact that the equations calculated are, actually, also estimates, extreme values found (minimum and maximum) were eliminated from further calculations (in Table 4 this relates to the figures in brackets). From the remaining values, the average size of the minimum sample has been calculated and rounded off corresponding to the decrease of the value $s_{\bar{x}(10)}$ by 30, 50 and 70 per cent (see Table 4).

RESULTS AND DISCUSSION

The results found are summarized in Tables 3 and 4. Without regard to the age and species of the fish studied, rounded-off average values of minimum samples corresponding to the decrease of the value $s_{\bar{x}(10)}$ by 30 (20 individuals), 50 (40 individuals) and 70 (120 individuals) per cent were established. The sample corresponding to the decrease of $s_{\bar{x}(10)}$ by 70 per cent may be considered as satisfactory, because a further increase of the minimum sample by 100 individuals represents a further decrease of the value $s_{\bar{x}(10)}$ in perch only by 4.5 - 12.9 (avg. 8.2), in roach by 7.7 - 13.9 (avg. 10.7), in ruffe by 5.7 - 7.7 (avg. 6.9), and pike by 8.7 per cent.

Table 1. Statistical characteristics of total samples at examined fishes ($\bar{x}$ - arithmetical mean, s - standard deviation, $s_{\bar{x}}$ - standard error of the mean, n_t - total number of individuals, AG - age group, BL - ranges of body lenght in mm)

Species	n_t	AG	BL	$\bar{x}$	s	$s_{\bar{x}}$
Rutilus rutilus	459	2	90 - 210	131.0	20.17	0.94
	381	3	91 - 232	183.3	24.40	1.25
	260	4	111 - 240	202.3	18.30	1.14
	219	5	145 - 255	209.8	22.80	1.54
Perca fluviatilis	379	2	97 - 175	126.8	11.53	0.59
	273	3	115 - 190	144.9	15.559	0.94
	182	4	130 - 210	170.4	15.37	1.14
	74	5	150 - 230	184.1	15.38	1.79
Gymnocephalus cernuus	220	1	52 - 85	64.9	6.46	0.44
	568	2	60 - 95	76.9	6.62	0.28
	508	3	70 - 111	85.0	6.75	0.29
	193	4	70 - 115	92.1	7.26	0.52
Esox lucius	155	3,4	380 - 690	489.5	60.40	4.85

When studying the bleak from the Brno riverine lake (n = 221, from 2nd to 5th AG) W o h l g e m u t h (1984) stated the minimum sufficient sample of 50 specimens while following the total length of the fish and determining the sufficient sample only from the course of the curve, which was not expressed by the use of the equation. His paper, however, does not include the ranges of the length of the fish measured. If this evaluation was based on the own criterion from by me asseses curve ($y = 25.69 \,.\, x^{-0.53}$), it is possible to obtain the values for 20 individuals (the lowering of $s_{\bar{x}(10)}$ about 30 %), 38 individuals (the lowering $s_{\bar{x}(10)}$ about 50 %) and 100 individuals (the lowering of $s_{(10)}$ about 70 %).

L i b o s v á r s k ý (1968) has studied from this point of view the age classes II and III at the brown trout from the Loučka creek. He has found from the curve (not expressed by the use of equation) correlating the standard error of the mean and the number of individuals in the sample it can be gathered that the sample counting 30 to 40 individuals can be regarded as sufficient in the age class II and II separately.

Table 2. Illustration of the dependence of the standard error of the mean ($s_{\bar{x}}$) on the number of individuals (np) of the roach (2.AG) randomly selected from the total sample (n_t = 459); $\bar{x}$ - arithmetical mean, s - standard deviation

n_p	$\bar{x}$	s	$s_{\bar{x}}$
2	127.5	3.5	2.5
3	143.3	30.6	17.6
4	148.0	19.2	9.6
5	130.6	30.9	13.8
10	130.1	20.9	6.6
15	134.0	15.8	4.1
20	126.3	25.7	5.8
25	133.1	27.3	5.5
30	134.0	19.6	3.6
35	136.6	21.1	3.6
40	132.8	22.6	3.5
45	137.7	23.6	3.5
50	136.6	21.8	3.1
60	131.0	20.9	2.7
70	134.2	21.8	2.6
80	134.7	20.8	2.3
90	138.6	21.6	2.2
100	134.6	22.1	2.2
150	134.2	20.8	1.7
200	138.8	22.6	1.6
250	132.4	21.3	1.4
300	136.1	21.2	1.2
350	130.6	19.9	1.1
400	132.0	20.7	1.0
459	131.0	20.2	0.9

Besides I have compared hypothetical samples characterized with the identical value $s_{\bar{x}}$ and number of individuals, but with different averages (the difference 5 mm, 10 mm and 15 mm). I have used for the calculation own equation corresponding to the roach at the age 3 (see Table 3). T-test was used for the statistical comparison. I have not found the significant difference ($P > 0.05$) nor by the use of 350 individuals, when the difference between sample average was only 5 mm. When the difference between sample averages was 10 mm, the significant (difference $P < 0.05$) was confirmed at the sample n = 30, high significant difference ($P < 0.01$) was confirmed at the sample size of 200 individuals. In the case of difference 15 mm between sample averages compared, the significant difference ($P < 0.05$) was found already at the sample n = 10, high significant difference ($P < 0.01$) was confirmed at the sample of 30 individuals.

Table 3. Parameters of exponential equations illustrating dependence of the standard error of the mean on the number of individuals in randomly selected samples (n_t - total number of individuals, r - correlation coefficient)

Species	n_t	AG	a	b	r
Rutilus rutilus	459	2	21.04	- 0.4861	- 0.981
	381	3	20.58	- 0.4709	- 0.966
	260	4	45.24	- 0.5574	- 0.996
Perca fluviatilis	379	2	13.31	- 0.5407	- 0.992
	273	3	10.11	- 0.4069	- 0.955
	182	4	11.93	- 0.4459	- 0.998
	74	5	28.07	- 0.6244	- 0.989
Gymnocephalus cernuus	220	1	5.64	- 0.4781	- 0.974
	568	2	6.51	- 0.4934	- 0.995
	508	3	4.76	- 0.4402	- 0.965
	193	4	6.45	- 0.4679	- 0.992
Esox lucius	155	3,4	63.34	- 0.5047	- 0.997

Table 4. Minimum sufficient samples size necessary to the lowering of the value of standard error of the mean ($s_{\bar{x}(10)}$) about 30 %, 50% and 70% (n_t - total number of individuals, AG - age group).

Species	nt	AG	lowering about 30%	lowering about 50%	lowering about 70%
Rutilus rutilus	459	2	21 ind	42 ind.	120 ind.
	381	3	21	43	130
	260	4	(17)	(29)	(63)
	260	5	20	35	90
Perca fluviatilis	379	2	19	36	92
	273	3	(24)	(56)	(190)
	182	4	22	47	150
	74	5	18	30	70
Gymnocephalus cernuus	220	1	21	42	130
	568	2	20	40	110
	508	3	23	49	150
	193	4	22	45	130
Esox lucius	155	3,4	20	39	110
total average without extreme values (in brackets)			21	41	117

SUMMARY

In the present paper the problem of the minimum sufficient sample for the growth studies of fish population was discussed in application to actual populations of the perch, the roach, the ruffe and the pike. When examining the variability in the body length of the fish of the same age, the minimum samples were stated from the curves of the dependence between the increase of the size of a random sample and the corresponding decrease of $s_{\bar{x}(10)}$ (standard error of the mean). As the base, the value of $s_{\bar{x}(10)}$ corresponding to a randomly caught sample of 10 individuals was taken. The average and rounded-off minimum sample necessary for the decrease of the value $s_{\bar{x}(10)}$ by 30 per cent represented, without regard to the species and age of the fish studied, 20 individuals, while for the decrease by 50 per cent a sample of 40 individuals and by 70 per cent that of 120 individuals, respectively, was necessary. Analogous values are to be supposed to exist also in the other species of our fish.

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LITERATURE

Davison V. E., 1940: A field method of analyzing game bird foods. *J. Wildl. Mgmt.*, 4:105–116.

Hanson W. R., Graybill F., 1956: Sample size in food-habits analyses. *J. Wildl.Mgmt.*, 1:64-68.

Korschgen L. J., 1948: Late-fall and early-winter food habits of bobwhite quail in Missouri. *J. Wildl.Mgmt.*, 12:46-57.

Kratochvíl J., et al., 1959: Hraboš polní - Microtus arvalis. Nakl. ČSAV, Praha, 1-359.

Libosvárský J., 1968: A study of brown trout population (Salmo trutta m.fario L.) in Loučka Creek (Czechoslovakia). *Acta Sc. Nat. Brno*, 2,7:1-56.

Mišík V., 1962: Einfluss der Anzahl der Probeexemplare auf die Erfassung der statistischen Charakteristiken der meristischen Merkmale des Brassens (Abramis brama L.) *Věst. čs. Společ. zool.*, 26,2:174-188.

Obrtel R., Holišová V., 1977: Sufficient sample size for analyses of small rodent diets. *Folia Zool. Brno*, 26,3:193-205.

Roth P., Ráb P., 1987: Estimation of minimum necessary sample size in the morphometrics of Bufo viridis (Amphibia : Anura). *Folia Zool.*, 36,1:27-34.

Sládek J., 1975: K problematike stanovenia optimálnej veľkosti vzorky pri výskume zloženia potravy mäsožravcov metódou rozboru žalúdkov. *Lynx* (Praha), N.S., 17:72-76.

Wohlgemuth E., 1984: O minimální velikosti vzorku pro studium rybích populací. *Vertebrat. zprávy*, 91-94.

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LENGTH AND WEIGHT GROWTH OF THE PIKE, ESOX LUCIUS (PISCES, CLUPEIFORMES) IN THE BOHEMIAN RIVERS VLTAVA AND BEROUNKA

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A b s t r a c t . Authors present their results of the growth study of the pike *(Esox lucius)* based on scale samples obtained by anglers throughout 1953 - 1988 from the River Vltava and its Central Bohemian affluent, the River Berounka. 186 specimens of the pike of the body length 345 - 960 mm were used for the analysis of the length and weight growth. The growth parameters (L_∞, Fulton's coefficient, length-weight relationship) were evaluated. Average values of the length growth within various types of the pike's habitat in Czechoslovakia are also quoted.

INTRODUCTION

The pike is the main piscivorous fish of our freshwaters of high value for angling. It fulfils also an important role of being a predator of scrab fishes in the water ecosystem. A considerable number of Czechoslovak papers have dealt with its growth, e. g. Č i h a ř (1955, 1961), O l i v a (1956), F r a n k and V o s t r a d o v s k ý (1961), B a l o n (1965), H o l č í k (1968), V o s t r a d o v s k ý (1969, 1970 a, b), S e d l á r (1971 a, b), P o u p ě (1974), T a n d o n and O l i v a (1978), O l i v a et al. (1979), O l i v a and N a i k s a t a m (1979), J o h a l (1980), H a n e l (1988, 1989, 1990). Many valuable data concerning the pike were summarized also in the paper of T o n e r and L a w l e r (1969).

The present communication completes data summarized by T a n d o n and O l i v a (1978), who dealt partially with the pike from the rivers Berounka and Vltava. Having for disposal further scale samples from the River Vltava (years 1953 - 1978) and from the River Berounka (1970 - 1988) it was possible to ascertain the long term growth average of the pike's growth in selected parts of both the rivers in Central Bohemia.

MATERIAL AND METHODS

As to the methods used, we started from O l i v a (1956) where also the body-scale relationship in the pike was discussed, with notes on the age determination following the scale structure, Fulton's coefficient, and the length-weight relationship. For the back calculation of the length growth the method of Rosa Lee was used. The length of the young pike at the beginning of the scale formation was found to be 40 mm. The back calculation of the weight growth was performed using the method of R o u s e f e l l and E v e r- h a r t (1960). The relationship between the body length (SL) and weight (W) was ascertained by F u l t o n ' s coefficient which has represented, until recently suitable parameter for fish growth studies (G e r ž a n o v i č et al., 1984).

The pike was angled in the River Vltava at several places in the territory of the city of Prague from April to November, the prevalent part of specimens having been caught in autumn. The composition of the material examined was as follows: the year of the capture 1953, the age 3+1 specimen, 5+1 sp., 8+1 sp.; 1954 : 4+1 sp.; 1964 : 9+1 sp.; 1965 : 3+3 sp.; 4+1 sp.; 1969 : 3+3 sp., 4+3 sp., 5+1 sp., 7+1 sp.; 1970 : 4+1 sp.; 1971 : 2+1 sp., 3+6 sp., 4+3 sp., 9+1 sp.; 1972 : 3+5 sp., 4+2 sp.; 1974 : 7+1 sp.; 1975 : 3+1 sp., 4+1 sp., 6+1 sp.; 1977 : 3+2 sp., 4+1 sp.; 1978 : 2+3 sp., 7+1 sp.

The River Vltava in this part of its lower stream flows through the Prague plateau and its average discharge at its mouth into the River Elbe is 149.9 $m^3.s^{-1}$ (V l č e k et al., 1984). With regard to the fact that the pike is mainly piscivorous, the ichthyofaunistical composition of both the rivers in sections where also the pike was angled must be mentioned. V o s t r a d o v s k ý et al. (1973) studied the occurrence of fishes using gill nets and electrofishing in 17 localities in the Prague district of the Vltava. They confirmed 29 fish species here. Most frequent were *Rutilus rutilus, Leuciscus leusciscus, Leuciscus cephalus, Perca fluviatilis, Scardinius erythrophthalmus, Tinca tinca, Gobio gobio, Barbus barbus, Alburnus alburnus, Blicca bjoerkna, Vimba vimba, Anguilla anguilla, Carassius carassius.*

Further scale samples were obtained from the left side tributary of the Vltava, namely the River Berounka, which has the average discharge 36 $m^3.s^{-1}$ (V l č e k et al., 1984) at its mouth. Here samples were obtained from a section about 50 km long, from the village Skryje to the mouth of the Berounka, prevalently in September (75.5% of samples) and in October (23%), a small portion having been obtained in August (only 1.5% of the total catch). The composition of the material examined was as follows: 1970 : 2+1 sp., 5+5 sp.; 1972 : 3+1 sp., 4+4 sp., 5+1 sp., 6+1 sp.; 1973 : 3+7 sp., 4+5 sp., 7+1 sp.; 1974 : 2+2 sp., 3+3 sp., 4+1 sp., 4+1 sp., 5+3 sp., 6+1 sp.; 1975 : 3+3 sp., 4+4 sp., 5+1 sp., 7+2 sp.; 1976 : 3+4 sp., 4+3 sp., 5+1 sp.; 1977 : 2+9 sp., 3+8 sp., 4+5 sp., 5+3 sp., 7+1 sp.; 1978 : 3+1 sp., 4+1 sp.; 1979 : 3+1 sp., 4+1 sp.; 1980 : 3+2 sp., 4+1 sp., 5+1 sp., 6+1 sp.; 1981 : 3+3 sp., 4+1 sp., 6+1 sp.; 1982 : 3+2 sp.; 1983 : 3+6 sp., 5+1 sp., 6+1 sp., 11+1 sp.; 1984 : 2+2 sp., 4+5 sp., 5+1 sp., 8+1 sp.; 1985 : 2+1 sp., 3+4 sp., 4+1 sp., 5+1 sp.; 1986 : 2+3 sp., 3+2 sp., 4+1 sp.; 1988 : 3+3 sp., 4+5 sp., 5+4 sp.

V o s t r a d o v s k ý et al. (1978) confirmed, on the basis of the analysis of catches during an angling competition the presence of the following 11 fish species in the lower part of the stream of the Berounka: *Alburnus alburnus, Blicca bjoerkna, Vimba vimba, Rutilus rutilus, Leuciscus cephalus, Leuciscus leuciscus, Gobio gobio, Scardinius erythrophthalmus, Abramis brama, Perca fluviatilis, Cyprinus carpio.* While angling, various individuals collected scale material from the River Berounka, and from this sample, transferred to the Department of Zoology, Fac. Sci., Charles University, Prague, it is evident that the predominant angled species were: *Vimba vimba, Blicca bjoerkna, Rutilus rutilus, Cyprinus carpio* and *Abramis brama.*

RESULTS AND DISCUSSION

The values of the length growth in our own material of the pike are summarized in Tables 1 - 3. The growth of the females was better than of the males (Table 3). This fact was confirmed from our freshwaters, e.g., by B a l o n (1965), H o l č í k (1968),

Table 1. Length growth (in mm of the body length) of the pike (*Esox lucius*) in the river Vltava during 1953 - 1978

Age group	n	total length (mm)	body length (mm)	weight (kg)	l_1	l_2	l_3	l_4	l_5	l_6	l_7	l_8	l_9
2	4	450	394	1.20*	129	272							
3	21	541	471	1.49	146	270	386						
4	13	592	524	1.98	145	260	376	459					
5	2	583	505	1.55	156	255	345	415	468				
6	1	720	620	3.00	99	178	286	433	541	581			
7	3	843	733	5.30	127	270	378	501	585	660	702		
8	1	1 050	920	10.00	160	378	566	657	747	822	867	890	
9	2	930	815	6.55	127	222	364	459	550	621	688	738	783
ave.	47	714	623	3.88	136	263	386	487	578	671	752	814	783
min.		440	345	0.95	99	178	265	353	397	503	545	591	642
max.		1 080	950	10.00	194	378	566	663	772	865	912	890	924

* weighed one specimen only

Table 3. Average length growth of the pike (in mm of the body length) in rivers Vltava and Berounka, samples from 1953 - 1988

Locality	sex	n	l_1	l_2	l_3	l_4	l_5	l_6	l_7	l_8	l_9	l_{10}	l_{11}
Vltava	females	16	164	284	388	458							
min.			130	190	310	375							
max.			194	319	522	534							
Vltava	males	7	136	269	408	534	657	723	912				
min.			99	178	286	388	541	581					
max.			167	352	557	663	772	865					
Berounka	females[1)]	46	144	293	413	518	641	727	768	834	878	905	933
min.			89	158	260	349	486	668	767				
max.			200	358	528	672	760	816	769				
Berounka	males[2)]	50	135	267	356	447	534	603	643				
min.			91	167	261	322	454	580	609				
max.			174	379	514	582	649	625	677				

1) Parameters of von Bertalanffy's growth equation, $L\infty = 1\,157$, $K = 0.1519$, $T_0 = 0.0094$

2) $L\infty = 962$, $K = 0.1582$, $t_0 = 0.0675$

Table 2. Length growth (in mm of the body length) of the pike *(Esox lucius)* in the river Berounka during 1970 - 1988

Age group	n	total length (mm)	body length (mm)	weight (kg)	l_1	l_2	l_3	l_4	l_5	l_6	l_7	l_8	l_9	l_{10}	l_{11}
2	18	514	453	1.19	140	293									
3	55	530	465	1.41	142	274	393								
4	38	561	492	1.73	127	242	339	427							
5	17	713	632	3.44	132	251	368	474	577						
6	2	810	710	5.18	141	256	403	498	586	680					
7	5	780	682	4.31	123	257	346	446	526	601	649				
9	1	1 060	930	10.30	133	364	569	600	662	700	737	837	886		
11	1	1 090	960	9.60	131	268	349	495	614	696	769	832	878	905	933
ave.	137	757	666	4.65	134	276	395	490	593	669	718	835	882	905	933
min.		440	380	1.00	85	136	176	322	430	527	560	832	878		
max.		1 090	960	10.30	200	379	569	675	766	816	769	837	886		

Table 4. Comparison of average length growth (in mm of the body length) of the pike from various localities. Number of examined specimens in brackets

Locality	author	sex	age groups 2	3	4	5
Windermere res. 1946-47, England	Frost, Kipling /1959/	females	475/1/	613/9/	660/44/	693/30/
Windermere		males	445/1/	515/1/	601/18/	644/21/
Stour river, England	Mann /1976/	females	425/31/	530/18/	613/10/	696/8/
Stour river		males	397/33/	518/13/	577/8/	614/2/
Vyžlovák artificial pond, Bohemia	Klonfarová /1978/		389/14/	525/2/		
Orava res., 1960-62 Slovakia	Balon /1965/		357/28/	448/59/	461/55/	654/8/
natural ponds in Elbe river inundation, 1951-71, Bohemia	Poupě /1974/		325/18/	465/9/	593/4/	690/3/
Dunajec river, Slovakia	Oliva, Naiksatam /1979/		307/6/	394/12/	536/2/	-
Berounka river, Bohemia, 1969, 75-77	Johal /1980/		302/18/	380/12/	464/7/	506/3/
Berounka river, 1970-88	own values		293/18/	393/55/	427/38/	577/17/
natural pond Poltruba, 1953 Bohemia	Oliva /1956/		288/16/	453/10/	500/1/	-
Vltava river, 1953-78	own values		272/4/	386/21/	459/13/	468/2/

Sedlár (1971 a) and Vostradovský (1969, 1977). In England the same was observed by Frost and Kipling (1965). The theoretically attainable body length in the River Berounka in females (our own material, n = 46) was 1 157 mm, in males (n = 50), 962 mm. For 15 native localities, the largest theoretically possible body lengths were calculated in the range of 574 - 1 717 mm (the average value being 997 mm). These values were calculated from the total average length growth, and therefore they were influenced by different amount of pikes in individual age classes. In this respect we compared the length growth also in the same age groups separately (see Tab. 4). That is to say that in our own material the age 2nd is linked with the body length 293 mm, the age 3rd with 393 mm, the age 4th with 427 mm and the age 5th with 577 mm (see Table 4).

Table 5. Average length growth of the pike in various types of Czechoslovak waters /in mm of the body length/

Average from	l_1	l_2	l_3	l_4	l_5	l_6	l_7	l_8
2 artificial ponds 1)	291	398	496					
10 reservoirs2)	195	313	422	490	581	673	756	
5 rivers3)	181	295	386	484	570	686	740	804
6 backwaters, swamps, water filled depressions4)	162	287	408	541	634	727		
3 reservoirs5) /females/	230	341	440	531	641	733	809	
3 reservoirs5) /males/	221	330	419	490	553	610		

1) Artificial ponds Louňovák, Vyžlovák /Klonfarová, 1978/

2) Reservoirs /riverine lakes/: Dalešice /Lusk, Krčál, 1982/, Jesenice /Lusk, Krčál, 1982/, Klíčava /Frank, Vostradovský, 1961; Holčík, 1968/, Lion /Sedlár, 1971 b/, Lipno/Frank, Vostradovský, 1961; Vostradovský, 1977/, Opatovice /Lusk, Krčál, 1982/, Orava /Balon, 1965/, Římov /Kubečka, 1990/, Slapy /Hanel, 1989/, Záskalská /Švátora, 1981/

3) Rivers: Berounka /Johal, 1980; own values/, Dunajec /Oliva, Naiksatam, 1979/, Dyje /Lusk, Krčál, 1982/, Hron /Sedlár et al., 1989/, Vltava /Oliva, 1956; own values/

4) Backwaters, swamps, water filled depressions: Poltruba, Procházkova tůň, Velká Arazimova, V koutě /Oliva, 1956; Johal, 1980/, Kateřina, Modlany /Oliva et al., 1979/

5) Reservoirs (riverine lakes), see 2

The variability of the growth of the pike is well known. It depends mainly on the stationary habitat of the pike and on the food accessible there for single specimens (see e.g. Vostradovský, 1969). It is evident that for any precise studies of the growth of the pike it is necessary to have a rather numerous material so that both the slow and the fast growing specimens could be considered. In this respect the growth of the pike in both Vltava and Berounka was found to be very similar and comparable with previous data (Oliva, 1956; Tandon and Oliva, 1979; Johal, 1980). For both the rivers the average length growth was calculated for the period of 1953 - 88, using most numerous age groups (our own and other published data summed up, the

age from 2nd to 5th, n = 276) : l_1 - 179 mm, l_2 - 283 mm, l_3 - 369 mm, l_4 - 447 mm and l_5 - 527 mm of the body length.

On the basis of the recent knowledge of the pike growth in Czechoslovakia, the average growth in various types of waters was compared (Table 5). In the first years of life, the best growth of the pike was found in artificial ponds (however we examined only 2 localities) and in reservoirs (riverine lakes). However, the average differences in the body length in comparison with the three-year old specimens was not big, only 36 mm. Therefore it is necessary to collect further material from other localities, especially from rivers and artificial fish ponds. A more detailed comparison is not easy, because in each locality exist, obviously, considerable ranges of lengths with specimens of the same age, and the analysis depends, consequently, on a random representation

Table 6. Equations of relationship between body length and weight at the pike from various localities

Locality	author	n	equation
Reservoir Lipno, 1959 - 1967, males	Vostradovský /1970/	145	$\log_W = 3.2141 - 5.5639 \log L$
Reservoir Záskalská, 1974 - 1979	Švátora /1981/		$\log_W = 3.2122 - 5.5636 \log L$
Reservoir Klíčava, 1967 - 1969	Pivnička /1983/	35	$\log_W = 3.161 - 5.463 \log L$
Reservoir Lipno, 1959 - 1967, both sexes	Vostradovský /1970/	3 348	$\log_W = 3.1572 - 5.4133 \log L$
Reservoir Lipno, 1959 - 1967, females	Vostradovský /1970/	164	$\log_W = 3.1088 - 5.2835 \log L$
Reservoir Klíčava, 1975 - 1979	Pivnička /1983/	35	$\log_W = 3.036 - 5.109 \log L$
Various localities in Czechoslovakia, 1948-1953	Čihař /1955/		$\log_W = 2.9052 - 4.8021 \log L$
Reservoir Orava	Balon /1965/	187	$\log_W = 2.7985 - 4.4811 \log L$
Rivers Vltava and Berounka, females	own data	62	$\log_W = 2.7130 - 4.3903 \log L$
Rivers Vltava and Berounka, males	own data	57	$\log_W = 2.6027 - 4.1939 \log L$

of slow or fast growing specimens in the sample. This circumstance influences later the "average growth". V o s t r a d o v s k ý (1969) found that migrating pikes in the reservoir Lipno had smaller length and weight increments when compared with those specimens which have a stationary mode of life. The relation between the age and F u l t o n ´s coefficient in our material shows the tendency to lowering its value with the age (Tables 7 - 8). Ranges between F u l t o n ´s coefficient in own material were 1.04 and 1.57, respectively (the pikes from 2nd to 11th age groups). K o u ř i l et al. (1976) found ranges 0.76 - 1.57 (males from one to three years of age) in pikes from

artificial fish pond in the prespawning period; the same ranges with females were 0.77 - 1.24. The avearge value of F u l t o n 's coefficient grew with age. A larger value of this coefficient was found by V o s t r a d o v s k ý (1970 b) in female pikes from the

Table 7. The relationship between Fulton's coefficient /K/ and the age of the pike, own samples, rivers Vltava and Berounka, males

Age group	n	K	ranges
2	1	1.32	-
3	16	1.42	1.14 - 1.53
4	18	1.35	1.07 - 1.51
5	5	1.29	1.18 - 1.34
6	1	1.26	-
7	3	1.23	1.17 - 1.32

Table 8. The relationship between Fulton's coefficient /K/ and the age of the pike, own samples, rivers Vltava and Berounka, females

Age group	n	K	ranges
2	7	1.33	1.21 - 1.51
3	21	1.36	1.13 - 1.57
4	14	1.38	1.04 - 1.54
5	7	1.17	1.09 - 1.36
6	1	1.34	-
7	1	1.22	-
11	1	1.09	-

riverine lake Lipno, where he had calculated this index using the total weight. He confirmed the increase from June to October. F r a n k and V o s t r a d o v s k ý (1961) found the range of 0.77 - 1.23 in F u l t o n 's coefficient in the pike from the Klíčava reservoir (age of specimens 0+ to 4+). At the age 0+ the coefficient increased during June through to October, at the age 1+ F u l t o n 's coefficient decreased during July through to October. With pikes of higher age this tendency was not evident. H o l č í k (1968) confirmed the fluctuation of the coefficient "K" with the age of pikes in this reservoir (age of fish 1+ to 8+) between 0.96 - 1.05. But there the tendency to the decrease or increase of F u l t o n 's coefficient with the age of fish was not evident. It seems to be clear that F u l t o n 's coefficient can be applied in precise studies only when the fish of the same age and same sex are compared in the same period of the year.

The relation between the body length and the body weight of the pike in various localities is summarized in Table 6. Our own sample showed that males increased in weight faster up to the body length of 600 mm; later, a faster increase was observed in

Table 9. Relationship between the body length and Fulton's coefficient /K/ at the pike, own samples from

rivers Vltava and Berounka

body length /cm/		40 - 50	51 - 60	61 - 70	71 - 80	81 - 90	91 - 100
sex	males						
	n	25	9	7	-	-	1
	K	1.44	1.22	1.26	-	-	1.19
	min.	1.20	1.07	1.19	-	-	-
	max.	1.53	1.33	1.34	-	-	-
sex	females						
	n	32	7	6	2	2	1
	K	1.37	1.32	1.20	1.10	1.28	1.09
	min.	1.17	1.11	1.04	1.07	1.22	-
	max.	1.57	1.41	1.36	1.12	1.34	-

females and the growth of males was slower. The weight growth can be compared also using the index of production introduced by P i v n i č k a (1972). For Czechoslovak localities, he (P i v n i č k a , 1983) found ranges of $P_{I(4-8)}$ = 1 000 - 12 000 with the average of 5 000 g. When we used this method, the growth found in the Vltava was below the average ($P_{I(4-8)}$ = 2 426 g), and in the Berounka also below the average ($P_{I(4-8)}$ = 2 604 g).

SUMMARY

The long term average of the length and weight growth of the pike (n = 186, 2nd to 11th age group, body lengths 345 - 960 mm) from the lower part of the Berounka and from Prague part of the Vltava (Central Bohemia) was studied. In 1953 - 1988, the average length growth based on literary and the authors' data for the rivers mentioned, using the most abundant age groups (2nd to 5th), was as follows: l_1 - 179, l_2 - 283, l_3 - 369, l_4 - 447, l_5 - 527 mm of the body length. The ranges of F u l t o n 's coefficient within the age from 2nd to 11th were 1.04 - 1.57. Up to the body length of 600 mm, males increased faster in weight than females, later this relationship was reversed. When applying the index of production, in the rivers examined the average weight growth was below the average in comparison with other Czechoslovak localities.

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LITERATURE

Balon E. K., 1965: Wachstum des Hechtes (Esox lucius L.) im Orava-Stausee. *Zeitschrift für Fischerei und deren Hilfwissenschaften*. 1/2:113-158.

Čihař J., 1955: Systematické a biologické poznámky o štice (Esox lucius). *Univ. Carol. Biol.*, 1:1-18.

Čihař J., 1961: Růst ryb ve Slapské údolní nádrži v r. 1959. *Živ. výroba*, 6/4/:295-302.

Geršanovič A. D., N. B. Markevič, Ž. T. Dergaleva, 1984: Ob ispol'zovanii koefficienta upitannosti v ichtiologičeskich issledovanijach. *Vopr. ichtiologii*, 24,5:740-752.

Frank S., Vostradovský J., 1961: Prvé poznatky o změnách, rozvoji a růstu štik a plotic v údolní nádrži Lipno. *Sbor. Kraj. vlastivěd. muzea v Čes. Budějovicích. Přírod. vědy*, 3:147-167.

Frost W. E., Ch. Kipling, 1959: The determination of the age and growth of pike (Esox lucius L.) from scales and opercular bones. *J. Con. Inst. L'Explor. Mer*, 24/2/:314-341.

Hanel L., 1988: Analýza úlovků velkých štik v Československu *Rybářství*, 2:30-31.

Hanel L., 1989: Ryby Slapské údolní nádrže a jejího povodí. MS, PhD Thesis, 160 pp. (In Czech only).

Hanel L., 1990: O stáří a růstu trofejních štik. *Rybářství*, 3:68.

Holčík J., 1968: Life history of the pike - Esox lucius Linnaeus, 1788 in the Klíčava reservoir. *Věst. čs. Společ. zool.*, 32:166-180.

Johal M. S., 1980: Further notes on the growth of pike, Esox lucius from Czechoslovakia. *Věst. čs. Společ. zool.*, 44:105-115.

Klonfarová H., 1978: Určování stáří a růstu slunky obecné (Leucaspius delineatus /Heckel, 1843/, hrouzka obecného (Gobio gobio /Linnaeus, 1758/, karase obecného /Carassius carassius /Linnaeus, 1758/) a štiky obecné (Esox lucius /Linnaeus, 1758/) z vybraných českých lokalit. MS. Dipl. Thesis, 68 pp. (In Czech only).

Kouřil J., Hamáčková J., Svobodová Z., 1976: Exteriérové a kondiční ukazatele štiky obecné (Esox lucius L.) z rybničního chovu v předvýtěrovém období. *Bul. VÚRH Vodňany*, 3:3-8.

Kubečka J., 1990: Věkové složení, růst a rozmnožování štiky obecné (Esox lucius) nádrže Římov. In: Ichthyofauna řeky Malše a nádže Římov. Jihočeské muzeum, České Budějovice, 114 - 118.

Lusk S., Krčál J., 1982: Štika obecná, Český rybářský svaz, 1-84.

Mann, R. H. K., 1976: Observations on the age, growth, reproduction and food of the pike Esox lucius (L.) in two rivers in Southern England. *J. Fish. Biol.*, 8:179-197.

Oliva O., 1956: K biologii štiky (Esox lucius L.). *Věst. čs. Společ. zool.*, 20,3:208-223.

Oliva O., Naiksatam A. S., 1979: Note on growth of some fishes from the river Dunajec. *Věst. čs. Společ. zool.*, 4:278-282.

Oliva O., Pivnička K., Švátora M., Závěta J., 1979: K poznání ichthyofauny dvou důlních propadlin u Teplic. In: Přírodovědecký výzkum těžebního pole Chabařovice-Jih. Teplice :396-430.

Pivnička K., 1972: Index of production- a new parameter for evaluation of growth and production capacity of fish illustrated with reference to roach, Rutilus rutilus (Linnaeus, 1758). *Věst. čs. Společ. zool.*, 36,4:269-274.

Pivnička K., 1983: Growth capacity of some fish species in different environmental conditions. *Věst. čs. Společ. zool.*, 47:272-287.

Poupě J., 1974: Note on growth of the pike, Esox lucius Linnaeus, 1758 in the Central Bohemia inundation area of the river Labe. *Věst. čs. Společ. zool.*, 38:279-284.

Rounsefell G. A., Everhart W. H., 1960: Fishery science its method and application. New York, 1-444.

Sedlár J., 1971 a: Prípad veľmi pomalého rastu šťuky obyčajnej. *Poľnohospodárstvo*, 17, 3:232-235.

Sedlár J., 1971 b: Príspevok k poznaniu veku a rastu Stizostedion lucioperca L. a Esox lucius L. v jazere

Lion. *Biologia*, 26:267-334.

Sedlár J., Makara A., Stráňai I., Holčík J., 1989: Atlas rýb. Obzor Bratislava, 1-373.

Švátora M., 1981: Dynamika rybích populací v Záskalské údolní nádrži. MS. Ph. D. Thesis, 137 pp., Praha.

Tandon K. K., Oliva O., 1978: Further notes on the growth of pike, Esox lucius from Czechoslovakia (Osteichthyes, Clupeiformes). *Věst. čs. Společ. zool.*, 42,1:69-76.

Toner E. D., Lawler G. H., 1969: Synopsis of biological data on the pike, Esox lucius Linnaeus, 1758. *FAO Fish. synops.*, 30,1:1-40.

Vlček V. et al. 1984: Zeměpisný lexikon ČSR. Vodní toky a nádrže. Academia, Praha, 1-316.

Vostradovský J., 1969: Značkování, migrace a růst značkovaných štik v údolní nádrži Lipno. *Bul. VÚR Vodňany*, 3:9-18.

Vostradovský J., 1970 a: Výpočet délkového růstu ryb podle Šentjakové na příkladu štiky obecné (Esox lucius L.) z Lipna. *Živ. výroba*, 16:497-507.

Vostradovský J., 1970 b: Vztah délky a váhy, koeficient kondice a vztahy délek u štiky (Esox lucius L.) z Lipna. *Živ. výroba*, 15/7-8/:497-507.

Vostradovský J., 1977: The age and growth of pike (Esox lucius L.) in the artificial reservoir Lipno. *Práce VÚRH Vodňany*, 10:21-46.

Vostradovský J., Leontovyč M., Vostradovská M., 1973: Ichthyofauna pražské Vltavy v letech 1970 - 1972. *Bul. VÚRH Vodňany*, 2:19-26.

Vostradovský J., Leontovyč M., Vostradovská M., 1978: Rozbor úlovků ryb udicí mistrovství světa (CIPS). *Bul. VÚRH Vodňany*, 1:31-34.

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CZECHOSLOVAK ENCHYTRAEIDAE (OLIGOCHAETA). III. DESCRIPTION OF A NEW SPECIES OF ENCHYTRONIA AND NOTES ON TWO SPECIES OF MARIONINA

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Abstract. *Enchytronia longispermatheca* sp.n. is described. Diagnosis of the genus *Enchytronia* is extended. The taxonomy of *Marionina cambrensis* O'Connor, 1963; and *M. asymmetrica* Nurminen, 1970 is discussed.

In the course of ecological studies on soil fauna in South Bohemia a new enchytraeid species, *Enchytronia longispermatheca* sp.n., was found. The species had three features which have not been reported in the genus *Enchytronia* so far. These features, which extend the original diagnosis of the genus, concern the free spermathecae, presence of seminal vesicles, and the structure of the alimentary canal in Segment VI. The changes bring the genus *Enchytronia* closer to the genera *Guaranidrilus* Černosvitov, 1937, corr. Healy, 1979, *Hemienchytraeus* Černosvitov, 1935, and *Tupidrilus* Righi, 1974.

MATERIAL AND METHODS

The soil samples were extracted by heat in wet funnels (O' Connor, 1955). Enchytraeids were identified alive in a drop of tap water under a light microscope. Some specimens were stained with Mayer's borax HCl alcoholic carmine and mounted whole in Canada balsam, others were sectioned in paraffin, and stained by hematoxylin-eosin. Setae were studied on slides with Liquide de Swanne. The material is deposited at the Institute of Soil Biology, České Budějovice. In the descriptions, Nielsen and Christensen's (1959) conventions were used.

Enchytronia Nielsen et Christensen, 1959 (extended)

The genus *Enchytronia* was erected by Nielsen and Christensen (1959) to include two species, *E. annulata* and *E. parva*. Four other species have been described subsequently: *E. christenseni* Dózsa-Farkas, 1970, *E. minor* Möller, 1971, *E. hellenica* Dumnicka, 1980, and *E. baloghi* Dózsa-Farkas, 1988.

Type species. *E. parva* Nielsen et Christensen, 1959.

Diagnosis. Setae straight without nodulus. Head pore at 0/I. Dorsal pores absent. Brain longer than wide, convex anteriorly and deeply indented posteriorly,

lateral margins converging towards the anterior end. Paired peptonephridia absent. Transition between esophagus and intestine at VI or VI/VII. A pair of lateral intestinal diverticula originating at the transition and extending forwards into VI; the diverticula communicating separately with the intestine through a canal which gives off finer branches into the body of the diverticula. If true diverticula missing, at least an expansions of esophagus at VI. Dorsal vessel arising in XIII. Blood colourless. Nephridia with well developed interstitial tissue; consisting of anteseptale with distinctly demarcated nephrostome and coils of nephridial canal, and an elongate postseptale with the efferent duct arising postero-ventrally. Seminal vesicle present or absent. Seminal funnel cylindrical. Vas deferens long and thin. Spermathecae free or unite entally and seem to be attached to the dorsal wall of the esophagus; no open communication with the esophagus has been observed. Genital organs in normal position.

R e m a r k s . Compared with the original version, the extended diagnosis of the genus *Enchytronia* Nielsen et Christensen, 1959, has more features in common with the diagnoses of the genera *Guaranidrilus* Černosvitov, 1937, corr. Healy, 1979, *Hemienchytraeus* Černosvitov, 1935, and *Tupidrilus* Righi, 1974. The key structures, which determine membership of the above genera, are compared in Tab. 1. The genus *Hemienchytraeus* distinctly separates from the assemblage by the presence of unpaired peptonephridia, attached dorsally to the pharynx, and by the absence of esophageal/intestinal appendages. The genera *Enchytronia* (extended), *Guaranidrilus* and *Tupidrilus* differ in the nature of the appendages of the alimentary canal at VI - X. In *Enchytronia* species the esophagus-intestine transition occurs at VI or VI/VII; at VI/VII there are paired diverticula, or the digestive tube in VI is only expanded and thick-walled. The *Guaranidrilus* species posses esophageal appendages in VI, and there is an abrupt transition of esophagus-intestine with two large, thin-walled, bilobed diverticula. However, either the appendages or the diverticula may have been lost in some species (C o a t e s and D i a z, 1988). The *Tupidrilus* species have either gradual or more or less sudden esophagus-intestine transition. Appendages attached at VI, are paired or unpaired and have a spongy appearance. The other features of these genera overlap to a variable extent. They are: position of head pore; setal presence/absence in some lateral bundles; origin of the dorsal blood vessel; arrangement of septal glands; and the form and structure of nephridia, spermathecae, seminal vesicle and penial bulbi. The presence of seminal vesicles in *Enchytronia* has been reported previously in *Enchytronia christenseni* Dózsa-Farkas, 1970 *E. minor* Moller, 1971, and *E. hellenica* Dumnicka, 1980.

G e o g r a p h y . *Hemienchytraeus* species occur largely in the tropics and subtropics of South America, Africa and Asia. Only one species has been reported from Europe (*H. bifurcatus* Nielsen et Christensen, 1959, Denmark). *Tupidrilus* species are restricted to S. America whereas the *Enchytronia* representatives have so far only been reported from Europe. The *Guaranidrilus* members occur in the tropics of S. America, and perhaps of Africa (doubtful species *G. lamottei* Omodeo, 1958), and one species has

been reported from Europe (*G. europaeus* Healy, 1979, South France, Pyreneés). Recently this genus has also been reported from North America (C o a t e s and D i a z, 1988).

Enchytronia longispermatheca sp. nov.

(Figs. 1 - 6)

D e s c r i p t i o n . Colour normally white. Live length (3.5) 4 - 4.5 (5) mm, width 130 - 150 μm (165 μm in clitellar region). Number of segments (24, 25) 27 - 30 (31). Setae 2,0 - 2(1) : 2 - 2 (Fig. 4); seta about 28 - 30 μm long in front of clitellum and up to 43 μm behind it, with small ental hook. Lateral setae missing at VIII - XII. Head pore in furrow 0/I, laying longitudinally, length about 5 μm. Cutaneous glands hardly noticeable. Clitellum over XII - 1/2XIII, interrupted dorsally. The clitellar glands (granular clitellar cells), missing ventrally between the penial bulbi, arranged in approximately 26 transversel rows, with angular outline, the rectangular ones 7.5 - 10 x 15 - 18 μm; surface of glands of grain-like structure, the glands interspersed between grainless areas of globular clitellar cells. Brain with hind margin incised, about 125 μm long and 65 μm wide. Septal glands in three pairs at IV, V and VI, all with ventral lobes; first and second pairs with wide dorsal fusion, third pair not fused dorsally and formed by long ventro-lateral lobes only. Transition of esophagus-intestine immediately behind the septum V/VI; no diverticula present; digestive tube thick-walled in VI and 1/2VII, the wall internally with deep furrows bearing fine cilia. Chloragogen cells present in IV and V, sparse in VI and VII, dense from about VIII, partly missing in clitellar region; about 20 - 25 μm in diameter. Blood colourless; dorsal vessel originating on septum XIII/XIV. Coelomocytes oval, long axis 35 - 40 μm, finely grained (Fig. 3). Two pairs of nephridia anteclitellarly at VII/VIII and VIII/IX; length of entire nephridium about 90 - 100 μm, anteseptale approximately 1/4 of the length of postseptale; efferent duct arising posteroventrally; small hump on upper hind part of postseptale (Fig. 5), interstitial tissue well developed. Spermathecae free, commencing laterally at IV/V, very long, up to IX, X or to septum X/XI, with a large compact gland at the ectal orifice; short part of ectal duct covered by small glands; narrow ectal duct gradually expanding into a sac-like ampulla; the ampullae over three segments long (Fig. 2). Seminal vesicles over 3 - 4 segments, most frequently X - XIII, coloured ochre brown. Sperm funnel as long as the diameter of the body, its length: width ratio about 2 - 2,5 : 1, collar narrower than diameter of the funnel. Vas deferens about 5 μm wide, extending to XIII, then back to XII. Penial bulbus compact, oval, about 75 μm long and 45 μm wide. Usually 1 (2) mature egg present at a time.

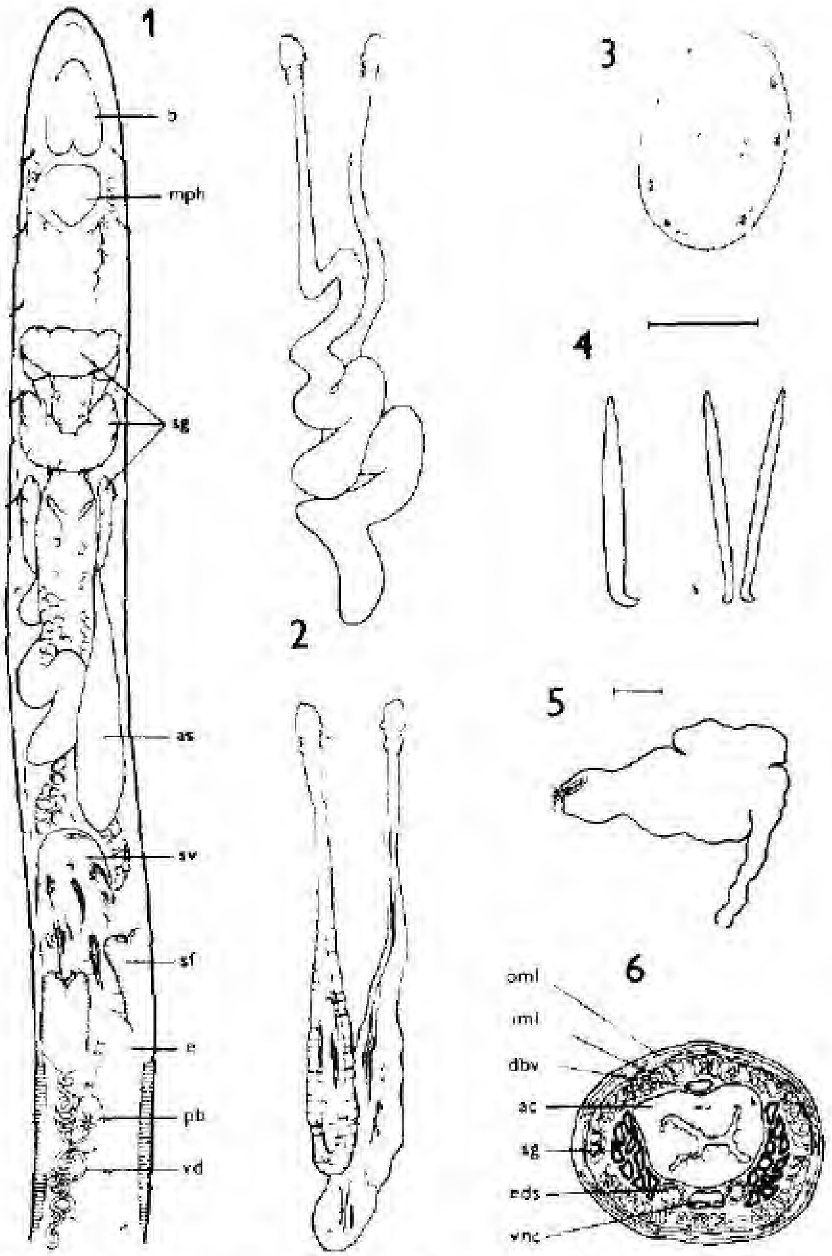
H o l o t y p u s Nr 1986/1 and 23 paratypes in author's collection are kept in the Institute of Soil Biology, České Budějovice

L o c u s t y p i c u s . Czechoslovakia, South Bohemia, district České Budějovice, near Hluboká nad Vltavou town, small grove of 100 - 120 year old beeches within a

	Enchytronia Nielsen et Christensen, 1959 extended	*Guaranidrilus* Černosvitov, 1937, corr. Healy, 1979	*Hemienchytraeus* Černosvitov, 1935 sensu N. & Ch., 1959	*Tupidrilus* Righi, 1974
dorsal blood vessel	arising in XIII	originating in clitellar region or just anterior to it	arising in XII-XIII	arising in front of or in the clitellar region
septal glands	3 pairs of primary	3 pairs united dorsally, with ventral lobes	3 pairs of primary	?
nephridia	interstitial tissue well developed, efferent duct arising postero-ventrally	interstitial tissue well developed, efferent duct terminal	interstitial tissue well developed, origin of efferent duct variable	interstitial tissue well developed
spermathecae	unite entally, attached to esophagus; or free	simple, no communication with esophagus	simple, no communication with esophagus	free, over several segments
seminal vesicles	present of absent	?	?	present
penial bulbi	compact	compact	compact, often reduced in size	present or absent
vas deferens	long	long and thin wound into spiral	long and often coiled into spiral	coiled into tight spiral
additional characters	seminal funnel cylindrical			one or more copulatory mamillae midventrally, off the nerve cord

Tab. 1. Key characteristics of the genera *Enchytronia* Nielsen et Christensen, 1959, *Guaranidrilus* Černosvitov, 1937, corr. Healy, 1979, *Hemienchytraeus* Černosvitov, 1935 and *Tupidrilus* Righi, 1974

	Enchytronia Nielsen et Christensen, 1959 extended	*Guaranidrilus* Černosvitov, 1937, corr. Healy, 1979	*Hemienchytraeus* Černosvitov, 1935 sensu N.&Ch., 1959	*Tupidrilus* Righi, 1974
head pore at	0/I	0	0	0
setae	straight, without nodulus	straight, 2 per bundle, without nodulus	straight, 2 per bundle	straight, 2 per bundle, may be missing in some segments, without nodulus
brain	deeply indented posteriorly	?	slightly incised or rounded posteriorly	?
esophagus-intestine transition	at VI/VII may be expanded	sudden	gradual or more or less sudden	gradual or more or less sudden
peptonephridia	absent	esophageal absent/present (Coates and Diaz, 1988)	unpaired dorsal salivary gland	pharyngeal absent
other appendages of esophagus or intestine	intestinal, paired diverticula extending forwards to VI, communicating with intestine, with inner canal; or absent	intestinal, paired, bilobed diverticula at transition esophagus-intestine or absent	no	esophageal, paired or unpaired, at VI, spongy



Figs. 1 - 6. *Enchytronia longispermatheca* sp. n.: 1 - internal anatomy, as - ampulla of spermatheca, b - brain, e - egg, mph - muscular pharynx, pb - penial bulbus, sf - sperm funnel, sg - septal glands, sv - seminal vesicles, vd - vas deferens; 2 - spermathecae; 3 - coelomocyte; 4 - setal bundle and single seta viewed laterally, 5 - nephridium at VII/VIII; 6 - transversel section at VII, ac - alimentary canal, dbv - dorsal blood vessel, eds - ectal duct of spermatheca, iml - inner muscular layer, oml - outer muscular layer, sg - septal gland, vnc - ventral nerve cord. Scale bars = 20 µm.

large mixed forest, close to the River Vltava, but on a plateau at the top of a steep slope about 60 m above the river. Sampling dates: 31st August, 1985, 2 juveniles; 21st April, 1986, 1 adult; 13th July, 1986, 36 adults.

Further locality. S. Bohemia, near Purkarec village, site in a mixed forest with beech. Sampling date 20th May, 1985, 12 adults, soil sample leg. V. Pižl.

Etymology. The species name reflects the abnormally long spermathecae.

Comments. The number of segments of 33 adult worms (13th and 16th July, 1986) was counted: 24 seg. (1 individual), 25 seg. (1 individual), 27 seg. (7 individuals), 28 seg. (6 individuals), 29 seg. (11 individuals), 30 seg. (5 individuals), and 31 seg. (2 individuals). One specimen has been observed with only one seta in a few lateral bundles behind the girdle. Another specimen lacked the lateral bundle on one side of the body at VII. The clitellum is not joined dorsally, as in some species of *Achaeta*, and is slightly elevated outwards. The transversel rows of clitellar glands are narrowly separated from each other. The ventral lobes of the first pair of septal glands are almost fully hidden under the dorsal fusion. The connectives of the septal glands, which join the first pair to the pharynx, are easy to observe. There are two tubercle-like swellings between these connectives just on the hind margin of the pharynx. They are likely to be nerve ganglia, also conspicuous in a number of other enchytraeids. The alimentary canal at VI and 1/2VII has thick hypertrophied walls. It appeared from observations on living worms that blind ending canals extended through these thick walls giving the impression that there must be some diverticulum, an extrusion of a hollow organ, with a narrow inner cavity. But series of transverse sections showed instead a few very deep furrows in the inner epithelium of the alimentary canal at VI (Fig. 6). The epithelium bore numerous cilia. In some specimens another small extension of the alimentary canal can be observed at XIII/XIV. The coelomocyte nucleus is not perceptible in the living state. These nuclei can, however, be observed temporarily in coelomocytes removed from the coelomic cavity, as the quickly disintegrating and grainy cytoplasma disperses. The grainy structured cytoplasma lies close to the periphery of the coelomocyte, and a condensed oval of cytoplasm occupies the centre of the cell. The spermathecae may be mildly crinkled or even bent forwards. The ectal duct together with the ampulla occupies about half the length of the spermatheca. The ampullae of some specimens are thin-walled, crammed with brown sperm, and fill up the coelomic cavity at VIII-X. In other specimens the ampullae are of different appearance, being thick-walled, generally narrower with smaller amounts of sperm. In the latter case either the spermathecae have not yet reached full development or they are stunted. Anyway, worms with such spermathecae are mature, as evinced by the presence of sperm in the spermathecae and the presence of fully developed reproductive organs. The seminal vesicles most frequently occupy four successive segments, and belong to, relative to the size of the worm, the largest vesicles which have ever been described in enchytraeids. The seminal funnel is about 150 μm

long and 70 μm wide, the collar partly dips and occupies about half the diameter of the funnel. The main body of the funnel has a grainy glassy structure. The vas deferens is initially irregularly coiled, then runs to XIII before turning back, closely applied to itself, to XII, so forming a long and narrow loop.

D i s c u s s i o n . The new species *Enchytronia longispermatheca* conforms to the extended diagnosis of the genus *Enchytronia* in all characters. It exhibits two features, particulary characteristic of *Enchytronia*. These features may be secondary but have a practical diagnostic importance. 1) Absence of lateral bundles in VIII - XII. This character is typical for almost all *Enchytronia* species known so far. Two exceptions have been reported. A few specimens of *Enchytronia* sp. possessed setae in all lateral bundles but XII (C h a l u p s k ý , 1986); the same was later stated for *Enchytronia balogbi* Dózsa-Farkas, 1988. 2) Inner structure of the coelomocytes. The cell cytoplasm, which appears to form very fine and smooth grains, is sometimes condensed into two rings, one close to the periphery of the cell, the other nearer the centre (Fig. 3).

Enchytronia longispermatheca is distinguishable from all other *Enchytronia* species by the length of the spermathecae and by having very large seminal vesicles. This species resembles the representatives of other genera in some morphological details. A similar hypertrophy of the wall of the alimentary tract at VI has been recorded in *Tupidrilus wilsoni* (Righi, 1973); the type of nephridium with a small hump occurs in *Hemienchytraeus shirensis* Bell, 1954 and in *Henlea africana* Bell, 1954; the brain with incised hind margin occurs in most species of *Guaranidrilus, Hemienchytraeus* and *Tupidrilus;* the spermathecae resemble those in *Hemienchytraeus cipoensis* Righi, 1973 and *Stercutus ugandensis* Bell, 1954, etc.; very large seminal vesicles have been reported in e. g. *Hemienchytraeus africanus* Černosvitov, 1935 (B e l l , 1954; C h r i s- t o f f e r s e n, 1977; R i g h i, 1973, 1974). These similarities suggest a fairly close phylogenetic affinity between *Enchytronia* species and members of *Guaranidrilus, Hemienchytraeus* and *Tupidrilus.* However, it would be unwise to consider these relationships further without personal experience of the living material.

The enchytraeid fauna in locus typicus was sampled five times in the period 31st August, 1985 - 13th July, 1987. A total of 15 enchytraeid species was discovered at the site; *Mesenchytraeus glandulosus* (Levinsen, 1884), *Cognettia sphagnetorum* (Vejdovský, 1878), *Achaeta* sp., *Enchytronia longispermatheca* sp. n., *Enchytronia* sp., *Henlea ventriculosa?* (d'Udekem, 1854), *Buchholzia appendiculata* (Buchholz, 1862), *Fridericia alata* Nielsen et Christensen, 1959, *F. paroniana* Issel, 1904, *F. ratzeli* (Eisen, 1872), *Fridericia* sp. 2, *Fridericia* sp. 6, *Enchytraeus* sp., *Marionina cambrensis* O'Connor, 1963 and *M. tubifera* Nielsen et Christensen, 1959. The juveniles of *Cognettia sphagnetorum* (D = 75 %) and *Buchholzia appendiculata* (D = 10 %) predominated. Adult *C.sphagnetorum* were collected on the 31st August, 1985, 12 individuals; 13th July, 1986, 1 subadult specimen. Adult *Buchholzia appendiculata* were identified on the 31st August, 1985, 2 individuals; 21st April, 1986, 1 individual; 13th July, 1986, 7 individuals.

Two terrestrial *Marionina* species were present in the enchytraeid community. Both species are new to Czechoslovakia, and therefore short descriptions are presented here.

Marionina cambrensis O'Connor, 1963

(Figs. 7 - 11)

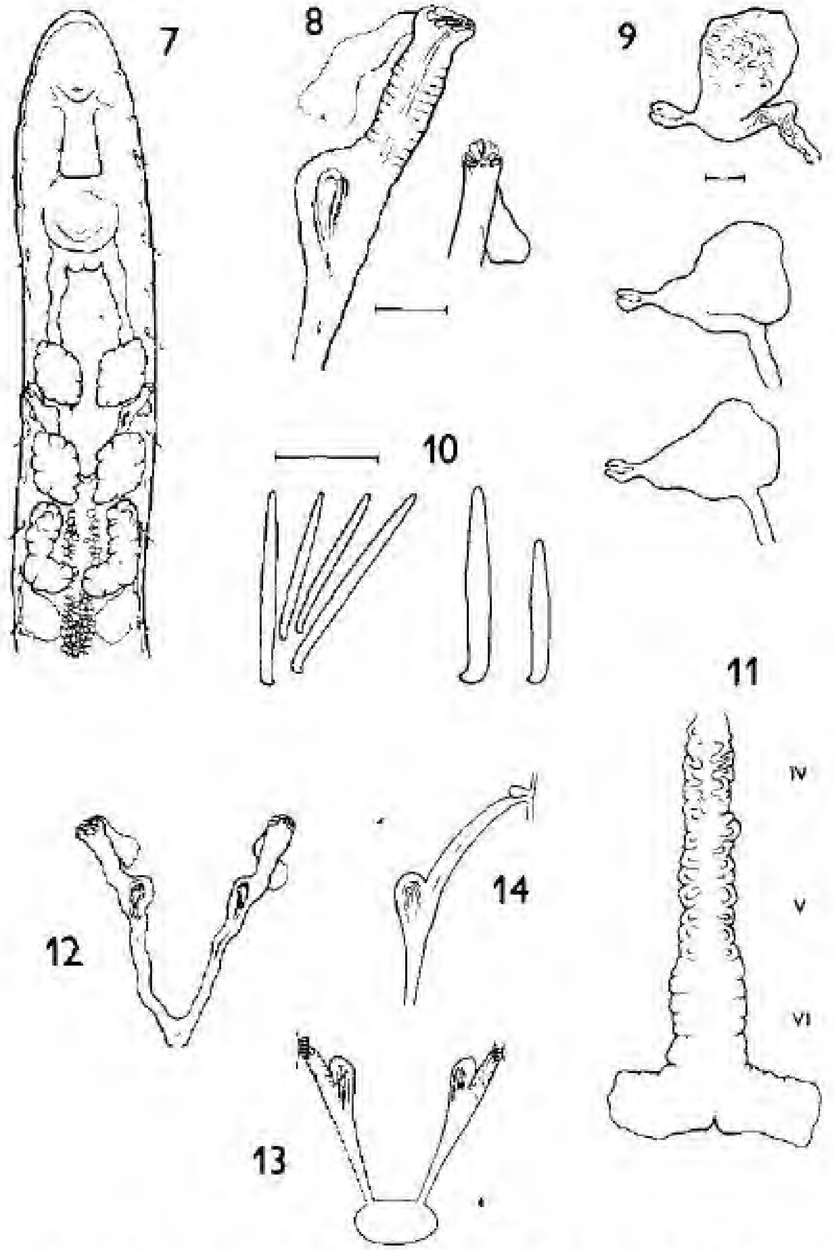
D e s c r i p t i o n . Size (5) 7 - 7.5 (8) mm alive, width about 200 - 250 μm. Number of segments (31, 34)36 - 39. Setal pattern (2) 3,4 - (4)3,2 : (1, 2, 3)4 - (4)3,2; setae arranged pair-wise, shorter pair in the middle of the bundle; when three setae in bundle, the larger seta towards the ventral midline in ventral bundles and the seta towards the dorsal side in lateral bundles are usually absent. The largest seta 37 - 38 μm long, the smallest 28 - 29 μm long anteclitellarly, all with small distal curve (*Fig.* 10). Septal glands in three pairs in IV, V, VI, the last pair long and narrower. Blood colourless, dorsal vessel originating at XIII/XIV. Coelomocytes oval, very finely grained, length: width about 25 - 27.5 : 17.5 - 20 μm, some cells up to 35 μm long. Four pairs of nephridia in front of the clitellum, from VI/VII to IX/X (Fig. 9). Esophageal appendages at VI, finger-like; the whole structure begins in IV and runs backwards on the ventral side of the esophagus, closely applied to the alimentary tube at IV - VI, ending at VI by two ventrolateral prominences (Fig. 11). This structure has a lobed outline and a narrow inner canal, the ends of it in VI are spongy. Spermathecae with one (rarely two) gland at the ectal orifice, the gland almost as long as the ectal duct. The ectal duct unilaterally expanded into an ampulla, which gradually narrows into a long ental duct (Fig. 8). Ental ducts join and together are attached to the esophagus at V between the lobes of the second pair of septal glands (Fig. 7). Seminal vesicles absent; in XI there are a few freely floating clusters of sperm. Usually one mature egg at a time.

L o c a l i t y . South Bohemia, Hluboká nad Vltavou, beech wood, as in *Enchytronia longispermatheca* sp.n. Sampling dates: 21st April, 1986, about 50 adults; 13th July, 1986, 5 adults; 9th January, 1987, 1 adult.

F u r t h e r l o c a l i t y . South Bohemia, České Budějovice, oak wood on the right side of a road to Branišov village. Sampling dates: 19th December, 1982, 4 adults, 8 juveniles; 16th February, 1983, 42 adults, 22 juveniles; 10th April, 1985, 48 adults, 34 juveniles.

D i s t r i b u t i o n . Great Britain (O'C o n n o r, 1963), Denmark (N i e l s e n and C h r i s t e n s e n , 1963), Sweden (C h a l u p s k ý , unpublished), Czechoslovakia, S. Bohemia, new record.

C o m m e n t s . The worms are normally whitish, but conspicuous due to a rusty--brown intestine, particularly behind the girdle. The outer as well as the inner setae have a sligthly narrower distal third (Fig. 10). Setae are missing in I, XII and the last body segment. On one occasioin free setae were observed in the coelomic cavity. Head pore about 20 μm long lies transversely at 0/I, essentially at the front margin of I. Dorsal pores missing. Some cutaneous glands arranged dorsally in 3 - 4 incomplete transversel rows in front of the clitellum, at III - XII. They are irregularly rectangular, being about 15 μm long. The clitellum covers 1/2XII - XIII, protruding outwards, less inwards. It consists of larger globular clitellar areas (about 15 μm in diameter) and



Figs. 7 - 13. *Marionina camberensis* O´Connor, 1963: 7 - internal anatomy; 8 - spermatheca; 9 - nephridium at VII/VIII and postclitellarly; 10 - setal bundle and setae viewed laterally; 11 - esophageal appendages; 12 - spermathecae (South Bohemia, original drawing); 13 - spermathecae (North Wales, O´Connor´s drawing).

Fig. 14. *Marionina asymmetrica* Nurminen, 1970, spermathecae (Finland, Nurminen´s drawing). Scale bars = 20 µm.

smaller granular clitellar cells (about 10 μm), mosaically arranged. Both types of gland are lacking around the male and female openings. Brain about 75 μm wide and 100 μm long, mostly truncated, but during strong contractions of the body its hind margin may occasionally appear to be slightly incised. The „peptonephridia" in IV - V look, in some individuals, like a series of small lobes, in others like a hollow thin-walled organ, which resembles that of *Fridericia*. They coalesce longitudinally with the ventral side of the esophagus. From V to VI the appearance of the peptonephridia changes, the lobes gradually turning into compact spongy prominences. The septal glands of each pair are separate, the first and second pairs have well developed ventral lobes, whereas the third pair is formed by ventrolateral lobes. The chloragogen cells are not clearly separated from each other. They are almost entirely reduced to small oil granules behind the girdle. The middle part of the intestine, usually in about XIV - XXIII, is covered or inlayed by longitudinal stripes of grains of unknown origin. The dorsal blood vessel was seen on one occasion to commence from septum XIII/XIV; the origin was difficult to ascertain in the other individuals examined. In some specimens, coelomocytes may be smaller than given in the description, being about 20 - 25 μm long. The coelomocyte outline is rugged in detail, not smooth, usually covered by a few hairs, by which the coelomocytes attach on to the body wall. The coelomocyte cytoplasm is finely grained. The nephridium is about 95 μm long. The anteseptale consists of a simple funnel. The efferent duct originates midventrally, immediately behind the septum, in preclitellar nephridia; in postclitellar nephridia the origin of the duct gradually shifts backwards, but it never starts terminally (Fig. 9). Spermatheca: the ectal duct occupies about a third or a quarter of the total spermatheca length and is 12 - 15 μm wide, then it expands unilaterally, into an ampulla, which is 20 - 30 μm wide; the ental duct is a simple tube which connects with its neighbour under the dorsal vessel (Fig. 12). This connection is extremely difficult to observe, it is mostly as narrow as the ental duct, although occasionally it is broader. In the middle of the combined duct there may be an aperture; on one occasion two adjacent apertures were seen. The seminal funnel has a length: width ratio of 2:1, it is 40 - 50 μm wide and the collar is the same width as the funnel or narrower. The vas deferens is loosely coiled, about 5 μm in diameter.

D i s c u s s i o n . The *Marionina* species identified as *M. cambrensis* in the present paper differs in minor details from *M. cambrensis* as described by O´C o n n o r (1963) and from *M. asymmetrica* Nurminen, 1970 (Tab. 2). The crucial feature is the spermatheca. *M. cambrensis* O´Connor, 1963 has a rosette of small glands at the ectal opening of the spermatheca, and the ental ducts enter a spacious common pouch with aperture (Fig. 13). *M.asymmetrica* Nurminen, 1970 has a longer ectal duct with a single small compact gland at the ectal orifice (Fig. 14). The ental situation was not described. The form of *M. cambrensis* described here has a short ectal duct with 1 (2) large gland at the orifice of it. The most distal part of the ectal duct is paved with glassy bodies (cells) (? O´Connor´s unicellular glands around the ectal aperture). The ental ducts are simply connected and the combined portion is tube-like, only rarely wider than the

preceding ental ducts. An ental aperture may occur (Fig. 12).

I have reexamined the original material of *Marionina asymmetrica Nurminen,* 1970, loaned by the Museum in Helsinki. It was two specimens preserved in ethanol, probably fixed in Bouin mixture, labelled *Marionina asymmetrica* Nurminen, TYYPPI, Tuusula, Ruotsinkyla, 25th October, 1968; M. Nurminen leg. det . . . I present a brief description of the gross morphology, as no serial sections or whole mounts were available. Length 4.9 and 5.1 mm, width 210 μm both specimens, width at clitellum 275 and 250 μm, segments 34? and 37, setal pattern (2) 3,4 - (4)3,2 : (2)3,4 - 4,3(2), length of longest seta 38 μm, length of inner seta 25 μm. This superficial examination would not in itself have enabled even the generic status of these type specimens to be determined without previous knowledge of the original author's determination. „There is also the ever present problem of fully identifying specimens in fluid preservative without the benefit of cleared whole mounting, dissecting or sectioning. Superficial resemblance may be misleading, and whole worms held as types may always be suspect because of this." (B r i n k h u r s t , 1981, p. 7)

Nurminen's later opinion was, that *M.asymmetrica* was a younger synonym of *M.cambrensis* O'Connor, 1963 (P. Turpeinen, letter communication of the 9th March, 1983).

Tab. 2. Comparison of *Marionina cambrensis* O'Connor, 1963 and *M. asymmetrica* Nurminen, 1970

Differential features	*Marionina cambrensis* O'Connor, 1963 North Wales	*Marionina cambrensis* O'Connor, 1963 South Bohemia	*Marionina asymmetrica* Nurminen, 1970 Finland
length mm	6 - 8	(5)7 - 7.5(8)	7
number of segments	34 - 37	(31, 34)36 - 39	36 - 41
setal pattern	2 - 4 per bundle	(2)3, 4 - (4)3, 2:(1, 2, 3)4 - (4)3, 2	3, 4 - 2: 4 - 2, 3, 4
hind margin of brain	slightly indented	truncated	truncated
3rd pair of septal glands in	VI - VII	VI	VI
origin of dorsal blood vessel	on septum XII/XIII	on septum XIII/XIV	in XIII
ectal duct of spermatheca	short	short	longer
ectal opening of spermatheca with	rosette of minute glands	1 (2) stalked large gland; end of ectal duct paved with glassy bodies (cells)	1 small compact gland
ental ducts of spermatheca	jointed in large common pouch with aperture	simply jointed, rarely more broadly, aperture occasionally	?
ventral structure of esophagus („peptonephridia")	present in IV - VI	present in IV - VI	?

Professor B. Christensen has seen live South Bohemian material of *M.cambrensis*

and commented, „This is what we usually call *M. cambrensis* O'Connor, 1963."

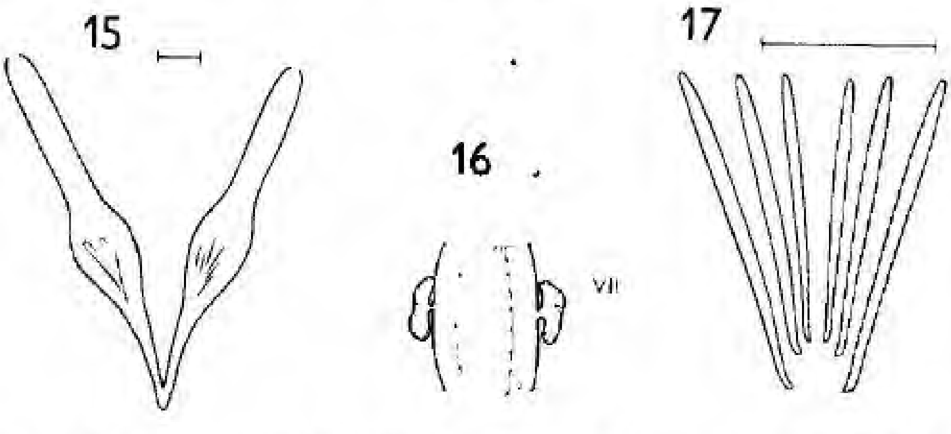
The unusual shape of spermatheca suggests that all three forms could be members of the same species. On the other hand, the spermatheca may simply reflect a common evolutionary pathway and the geographical distribution certainly indicates that these forms might be separate species (V. K o š e l, pers. communication).

At present, I am inclined to leave the situation as follows: the South Bohemian form is *M.cambrensis* O'Connor, 1963, but *M.asymmetrica* Nurminen, 1970 and *M.cambrensis* O'Connor, 1963 should remain separate species. Until live material from all three regions is compared, it would seem unwise to make any taxonomic changes.

Marionina tubifera Nielsen et Christensen, 1959

(Figs. 15 - 17)

D e s c r i p t i o n . Worms usually in a tube made of detritus and fine mineral particles. Length 6 - 7(8) mm alive, width 180 µm. Number of segments 37, 38. Setal pattern 2, 3, 4, 5, 6 - 6, 5, 4: (3)4, 5, 6 - 6, 5, 4; setae in bundles arranged pair-wise (Fig. 17), the inner pair shortest, as in the genus Fridericia. Septal glands in three pairs at IV, V and VI, separated dorsally, large ventral lobes in V and VI, ventral lobes in IV widely linked with strong connectives to pharynx. Dorsal vessel arising at XIII/XIV, blood colourless. Coelomocytes oval, 20 - 25 µm long, filled with refractile grains. Six pairs of nephridia in front of the clitellum, fron V/VI up to X/XI. Spermathecae without glands at ectal orifice, ectal duct rather suddenly expanded into ampulla, which is a bit wider than the duct, the ampulla slowly narrowing to ental part. Spermathecae communicate with each other entally (Fig. 15), fixed to esophagus. Seminal vesicle



Figs. 15 - 17. *Marionina tubifera* Nielsen et Christensen, 1959: 15 - spermathecae; 16 - intestinal swellings laterally at VII; 17 - setal bundle. Scale bars = 20 µm.

absent, only sparse bunches of spermatozoa present. At VII alimentary tube with a pair of small tuberculoid lateral swellings (Fig. 16).

Locality. South Bohemia, Hluboká nad Vltavou, beech wood, as in *Enchytronia longispermatheca* sp. n.. Sampling dates: 13th August, 1985, 4 adults; 21st April, 1986, 2 adults; 13th July, 1986, 3 adults and 1 juvenile; 9th January, 1987, 3 adults; 13th July, 1987, 2 adults.

Distribution. Denmark (Nielsen and Christensen, 1959), The Netherland (de Gunst, 1965), West Germany (Kasprzak, 1986), Czechoslovakia, S. Bohemia, first record.

Discussion. In all features but two, body size and swellings on intestine in VII, these specimens fit very well the description of Nielsen and Christensen (1959, p. 117, Figs. 153 - 155). These authors found the length to be 10 - 15 mm and they did not mention the intestinal swellings in VII.

Including the species *Enchytronia longispermatheca* sp. n., *Marionina cambrensis* O'Connor, 1963 and *M. tubifera* Nielsen et Christensen, 1959, the enchytraeid species list for Czechoslovakia consists of 58 species (Propappidae excluded) (Chalupský, 1988).

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I wish to thank Prof. Veikko Huhta (University of Jyväskylä), Dr. Juhani Terhivuo and Dr. Pauli Turpeinen (both University of Helsinki) for their assistance in loaning the original enchytraeid material. Dr. Vladimír Košel (Komenský University, Bratislava) constructively criticized the manuscript. Prof. Bent Christensen (University of Copenhagen) personally investigated the live South Bohemian worms of *Marionina cambrensis* O'Connor, 1963. And Dr. Michael A. Learner (University of Wales, Cardiff) revised the English draft and added some helpful comments.

LITERATURE

Bell A. W., 1954: Some enchytraeid worms (Oligochaeta) from East Africa. *Trans. Amer. Microcs. Soc.*, 73: 297 - 311.

Brinkhurst R. O., 1981: On the Types of Tubificidae (Oligochaeta) Described by W. Michaelsen and Others in the Zoological Institute and Zoological Museum, University of Hamburg. *Mitt. hamb. zool. Mus. Inst.*, 78: 7 - 17.

Chalupský J., 1986: Czechoslovak enchytraeids (Oligochaeta, Enchytraeidae) I. Enchytraeids from an apple orchard by Bavorov in South Bohemia. *Věst. čs. Společ. zool.*, 50: 13 - 21.

Chalupský J., 1988: Czechoslovak enchytraeids (Oligochaeta, Enchytraeidae) II. Catalogue of species. *Věst. čs. Společ. zool.*, 52: 81 - 95.

Christoffersen M. L., 1977: New Species of Guaranidrilus Cernosv. (Enchytraeidae, Oligochaeta) from Serra do Mar, Sao Paulo, Brazil. *Stud. Neotrop. Fauna Environ.*, 12: 187 - 206.

Coates K. A., Diaz R. J., 1988: Description of Guaranidrilus oregonensis (Oligochaeta:

Enchytraeidae) from North America, with additional comments on the genus. *Proc. Biol. Soc. Wash.*, 101: 773 - 783.

de Gunst S. H., 1965: Enchytraeidae of the Netherlands (Annelid: Oligochaeta). *Beaufortia*, 13: 5 - - 12.

Healy B., 1979: Review of the genus Guaranidrilus (Oligochaeta, Enchytraeidae) with the description of two new species. *Bull. Br. Mus. nat. Hist.* (Zool.), 37: 7 - 15.

Kasprzak K., 1986: Skąposzczety wodne i glebowe, II. Rodzina: Wazonkowce (Enchytraeidae). Klucze do oznaczania bezkręgowców Polski, Tom 5. PWN, Warszawa 1986, 365 pp.

Nielsen C. O., Christensen B., 1959: The Enchytraeidae, critical revision and taxonomy of European species (Studies on Enchytraeidae VII). *Natura Jutlandica*, 8 - 9: 1 - 160.

Nielsen C. O., Christensen B., 1963: The Enchytraeidae critical revision and taxonomy of European species (Studies on Enchytraeidae VII). *Natura Jutlandica*, 10: 1 - 19.

Nurminen, M., 1970: Four new enchytraeids (Oligochaeta) from southern Finland. *Ann. Zool. Fennici*, 7: 378 - 381.

O'Connor F. B., 1955: Extraction of Enchytraeid Worms from a Coniferous Forest Soil. *Nature* (Lond.), 175: 815 - 816.

O'Connor F. B., 1963: Marionina cambrensis sp. nov.: a new enchytraeid worm (Oligochaeta) from North Wales. *Ann. Mag. Nat. Hist.*, 5: 761 - 766.

Righi G., 1973: Sobre tres espécies brasileiras de Enchytraeidae (Oligochaeta). *Bol. Zool. e Biol. Mar.*, N. S., 30 (1973): 469-482.

Righi G., 1974: Notas sobre os Oligochaeta, Enchytraeidae do Brasil. *Papéis Avulsos Zool.* (S. Paulo), 28: 127 - 145.

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A CASE OF AN EXTREMELY LOW SHARE OF THE 0-AGE GROUP ON THE TOTAL BIOMASS, PRODUCTION AND RATION OF THE PERCH (PERCA FLUVIATILIS) POPULATION

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Abstract. The abundance, biomass, production and ration of the 0-age class of the perch (*Perca fluviatilis*) was estimated 8-times during the period of May 1985 - January 1986 in the Římov Reservoir (Southern Bohemia). Due to high mortality of early larvae and to high mortality of juveniles in the period of mid June - mid August, the 0-age group represented only 17.7 % of the total perch production, 6.5 % of total perch population ration, and 0.54 % of the average total perch biomass (although 0-group represented 99 % of the average yearly perch abundance).

Only small influence of 0-age class of perch on the population of Daphnia galeata was observed. Such situation seems to be typical for the „suppressed" year classes in the cycling perch populations.

INTRODUCTION

Many studies show the great importance of 0-age group in the production of the fish populations (Mathews, 1971, Černý et Pivnička, 1973, Nyberg, 1979, Pivnička, 1979, Morgan et al., 1980, Treasurer, 1989 etc.) and in the total influence of the fish population on the food organisms (Mills et Forney, 1983, Van Densen et Vijverberg, 1982, Cryer et al., 1986 etc.). The amount of biomass comparable with the biomass of adult stock is often produced during the 1st year of life (from the original biomass of about 5 % of adult stock, i. e. the biomass of the newly hatched larvae). High mortality rate occurs regularly.

This study was aimed to estimate the production, number, growth, biomass and ration of the suppressed perch year class (i. e., the age class that is under strong cannibalism caused by the previous dominant year classes - comp. Menshutkin et Zhakov, 1964) and to compare them with the parameters of the total perch population.

MATERIAL AND METHODS

The estimation of the abundance, biomass, production and ration of the 0-age group was done in the Římov Reservoir (Southern Bohemia, area 210 ha, altitude 470 m above the sea level, volume $33.5.10^6$ m^3, for a more detailed description see Stach et Kubečka, 1990). The abundance of the 0-age group

of the perch (P e r c a f l u v i a t i l i s) was estimated 8-times during 1985:

1. On April 28-th (the date of culmination of the spawning of the perch females), the population fecundity of perch was estimated using the data of adult stock abundance (K u b e č k a , 1990 a) and the body length-fecundity relationship according to Z á l e s k ý (1996). The sex ratio in the perch population was supposed to be 1:1 (Š v á t o r a , 1981).

2. On May 12-th (the time of mass hatching), the estimation of the population fecundity was decreased by 25 % (nonfertilised and destroyed eggs, incubation losses - see T r e a s u r e r (1983), M e l a r d et P h i l i p p a r t (1984), our direct observations of the proportion of dead eggs in clutches).

3. During May 16 - 23-rd, quantitative samplings of pelagic larvae by the Clarke Bumpus Sampler (diameter 30 cm) were done at the depths 0 - 30 m (see K u b e č k a et S l a d, 1990). The sampling of May 22-nd provided the most reliable estimation of the larval abundance (majority of them moved to the depths about 20 m on the developmental stage C_1 - according to L a n g e et al. (1977); the recruitment of newly hatched larvae became low at this time). The coefficient of variation of the catches of the perch larvae in different depths was 14 %. The census of larvae was done according to their real proportion of the depths of 20 m and more in the reservoir.

4. On June 12-th, the next census of the perch larvae using the conical net with the diameter 1 m and the mesh 1 mm was done (see K u b e č k a et S l a d , 1990). This census was also made according to the proportions of the depths 20 m and more and multiplied twice due to the gear avoidance behaviour of the larvae. The assumption of 50 % avoidance of larvae in the June sample was developed as the most probable number. The avoidance behaviour of perciform larvae occurs in a quite early developmental stage (8 mm length larvae - N o b l e 1970). I suppose an equal probability of larvae to avoid the sampling gear compared with the probability to be caught (i. e., catchability coefficient 0.5). A smaller catchability coefficient (0.3) is often used for postlarvae and juveniles in the Soviet literature (B o i t s o v 1980 etc.). At the same time (on June 14-th), the estimation of the catch per area of littoral was done. Results of both types of estimation together give the 0-age class abundance.

5., 6., 7. The June 14-th catch per area of littoral census was repeated again: on July 13-th, August 15-th and September 19-th. The coefficient of variation of the estimated abundance of perch fry in littoral was 27%.

8. The abundance of the perch fry to the date of January 15-th was calculated using the yearly survival rate of 0.333 (according to P i v n i č k a , 1982) and the results of the mark - recapture census of the 1985 year class in July 1986 (see K u b e č k a , 1990 a).

In total 4,511 individuals of larvae were caught, the number of the fry caught was 5,832 individuals.

The weights of larvae were determined on the basis of their average lengths (K u b e č k a et S l a d , 1990), using the length-weigth relationship of K u z n e t s o v (1972), until July 14-th. Later, the Length-weight relationship of K u b e č k a (1984) derived in the Klíčava Reservoir was used.

Using the data of abundance and weight of fish and the methods described in detail by K u b e č k a , 1990 b, the values of the biomass, production, and ration of the 0-age group of the perch during all their life in the season of 1985 were estimated. These values were compared with the values of the abundance, biomass, production and ration of the rest of the perch population (from K u b e č k a, 1990 a).

RESULTS

The development of the abundance of the 1985 year class of the perch in the Římov Reservoir is given in Fig. 1. The initial abundance of the eggs was estimated as 25 614, 700 inds.ha^{-1}. The abundance of the larvae decreased 20 times during the first 10 days after hatching. The daily mortality rate was 32 % (see Tab. 1).

In the next phase the mortality decreased slightly, but the mortality rate increased again after the return of the perch fry into the littoral zone, and the abundance

Table 1. The production, average biomass, daily mortalities, daily rations and daily productions of the perch O-age class in the Římov Reservoir in 1985 computed for the time intervals between the abundance censuses

Time interval	Total product. kg.ha^{-1}	Average biomass kg.ha^{-1}	Daily mortality %	Daily ration Mcal.ha^{-1}	Daily production kg.ha^{-1}
12. V. - 22. V.	2,65	10,1	32	2,44	0,265
22. V. - 12. VI.	4,95	2,02	6,5	1,0	0,236
12. VI. - 13. VII.	4,24	2,04	10,1	1,71	0,136
13. VII. - 15. VIII.	1,28	0,71	8,6	0,46	0,039
15. VIII. - 19. IX.	0,39	0,40	2,2	0,072	0,011
19. IX. - 15. I. 1986	0,15	0,44	0,27	0,026	0,0012

decreased more than ten times each month (from mid-June to mid-August). The next decrease of mortality rate was observed during the autumn.

The quick decrease of the abundance of perch fry resulted in the decrease of the average biomass, daily production, and ration. Due to the growth the biomass and

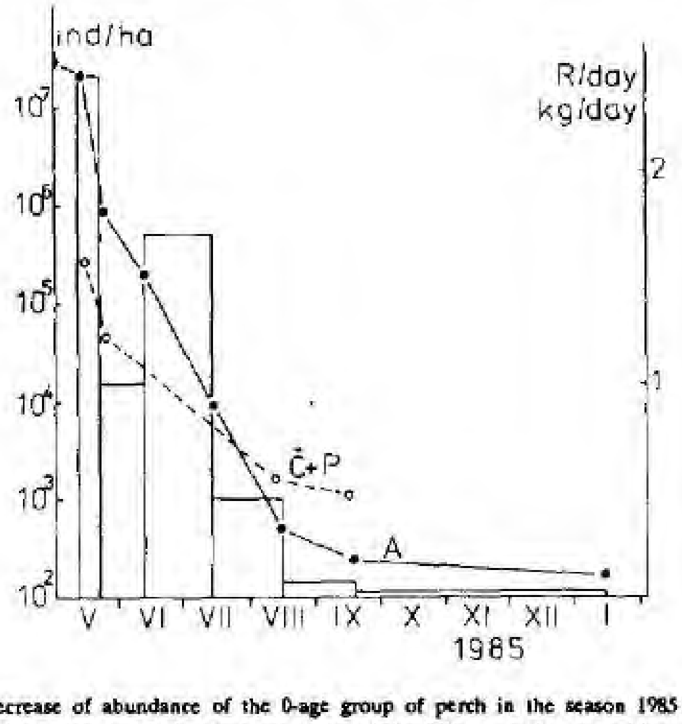

Fig. 1. The decrease of abundance of the 0-age group of perch in the season 1985 in the Římov Reservoir (Line A) compared with the same parameter of the Klíčava perch reported by Č e r n ý and P i v n i č k a (1973, line Č+P). The area of histograms represents the distribution of the perch fry ration during the season (ration.day^{-1} on the y-axis, number of days on the x-axis).

production were not continuously decreasing (in the case of daily production, the factor of decreased abundance seems to be the most important). The expression of the areas of the ration in the histogram in Fig. 1 represents the distribution of the ration consumed during the months of 1985.

The average abundance of the 1985 year class during the first year of life was 488,274 inds.ha^{-1}, which is 99 % of the abundance of the perch in the reservoir. The total production of 0-age group was 13.66 kg.ha, which represented 17.7 % of the total production of the perch population (with the exception of obligate piscivorous individuals). The total calculated ration of the 0-age group was 119.3 Mcal.ha^{-1}, which is 6.46 % of the total ration of the perch population in 1985 (also without piscivorous individuals). The average biomass of the perch 0-age group in 1985 was 1.19 kg-ha^{-1}, which is 0.54 % of the total perch biomass (without piscivorous individuals).

DISCUSSION

The extremely low share of the 0-age class in the biomass, production, and ration of the perch population does not agree with the majority of literature data (see Introduction). I believe that such a picture is typical in the case of the perch populations, exhibiting cyclic appearance of strong year classes followed by several weak ones (see M e n s h u t k i n et Z h a k o v, 1964, C r a i g, 1987 etc.). The initial abundance of eggs was relatively high (Fig. 1) also when evaluated according to our observation. The first critical phase of ontogeny seems to be the interval between hatching and filling of the swim bladder and the start of exogenous feeding (in this phase also the migration into depths 10 - 20 m occurs). Comparable literature data of daily mortalities are: 6.3 % - T r e a s u r e r, (1989), 25 % - M e n s h u t k i n et al., (1968), 36 % - V i l j a n e n et H o l o p a i n e n, (1982). Daily mortality within the range of 20 - 40 % probably occurs when the larvae of perch are considerably food limited (comp. M e n s h u t k i n et al., 1968). Majority of larvae caught in the Římov Reservoir had empty digestive tracts or had 1 or 2 food organisms in the gut - S l a d , 1988; much more food items - up to 32 - were found by T r e a s u r e r, 1989, in the case of probable absence of food limitation.

The phase of pelagic life exhibits smaller losses, supporting the conception of the ichthyoplankton phase as an adaptation to survive predation (W h i t e s i d e et al., 1985, P o s t et M c Q u e e n, 1988). No perch larvae were found in the stomachs of adult perch (K u b e č k a , 1989). The predation increased considerably during the demersal phase of life. The daily values of mortality stated for the O+ juveniles in the review of T r e a s u r e r (1989) - 2 to 9 % - are often lower than our values observed. Also the crossing of the plots of the abundances of the 0-age groups of perch in Klíčava and Římov Reservoirs (Fig. 1) illustrates the extremely quick decrease of the perch fry abundance in the Římov Reservoir, which in probably due to the cannibalism of older age groups of perch here. The total abundance of adult perches in the Římov

Reservoir was 4,630 inds.ha^{-1} in July 1985. The presence of approx. 2,000 inds.ha^{-1} of other fish species (roach, bream) was still unable to damp the strong self-regulation in the perch population

Two phases of extremely high mortality are responsible for the low values of production and ration (see Tab. 1) of O-age perch. Attempting to estimate the predation effect of the 1985 year class of perch on the population of *Daphnia galeata* using the data of stomach analyses of perch fry from 1985 - 1987 in the Římov Reservoir (*D. galeata* constituted a considerable part of the diet of the perch fry - 2 and 40 % in August and September - according to S l a d, 1988) we can conclude, that in only 10 % of the yearly ration *Daphnia* represents a considerable part. Therefore the summary effect of the O-age class of perch on *Daphnia* is less than 1 % of the effect of the adult part of population (preference of *D. galeata* by adult perch is high - K u b e č k a , 1989). Similar life history and small influence of O-age group can be supposed for other weak year classes of perch in Římov (1983 - 1988).

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LITERATURE

B o i t s o v M. P., 1980: Vertikalnoye raspredeleniye molodi v rayone raspolozheniya vodozabor Konakovskoy GRES. *Voprosy ichtiologii*, 26: 939 - 946.

C r a i g J., 1987: The biology of perch and related fish. Croom Helm, Lond., Sydney, Timber Press, Portland, Oregon, 333 pp.

C r y e r M., P e i r s o n G., T o w n s e n d, C. R., 1986: Reciprocal interactions between roach, Rutilus rutilus, and zooplankton in a small lake: Prey dynamics and fish growth and recruitment *Limnol. Oceanogr.*, 31: 1 022 - 1 038.

Č e r n ý K., P i v n i č k a K., 1973: Abundance and mortality of the perch fry (Perca fluviatilis Linnaeus, 1758) in the Klíčava Reservoir. *Věst. čs. Společ. zool.*, 37: 1 - 13.

K u b e č k a J., 1984: K poznání některých aspektů ekologie potěru ryb na Klíčavské údolní nádrži. MS thesis Charles Univ., Prague, unpubl., 207pp..

K u b e č k a J., 1989: Popisný model průběhu početnosti, biomasy, racionu a produkce rybí osádky a jeho využití v účelově obhospodařované vodárenské údolní nádrži. PhD. Thesis, CS. Acad. Sci, Č. Budějovice, unpublished, 121 pp.

K u b e č k a J., 1990 a: Početnost rybích populací Římovské nádrže a pokus o její rekonstrukci v předchozích letech. In: Kubečka J. (ed.): Ichthyofauna řeky Malše a nádrže Římov. Jihočeské muzeum, Č. Budějovice, 66 - 71.

K u b e č k a J., 1990b. Development of a model of fish population growth, abundance, biomass, production and ration. *Int. Rev. gesamt. Hydrobiol.*, 21 pp.

K u b e č k a J., S l a d P., 1990: Ichthyoplankton nádrže Římov. In: Kubečka J., (ed.): Ichthyofauna řeky Malše a nádrže Římov. Jihočeské muzeum, Č. Budějovice, 109 - 113.

K u z n e t s o v V. A., 1972: Kharakter rosta lichinok i molodi nekotorykh presnovodnykh ryb na raznykh etapakh razvitiya. *Voprosy ichtiol.*, 12: 479 - 489.

Lange N. O., Dmitrieva E. N., Peseredi E. N., Islamgaziyeva R. B., 1977: Osobennosti razvitiya molodi kostistykh ryb reki Ural. Nauka, Moscow: 112 pp.

Mathews C. P., 1971: Contribution of young fish to the total production in the River Thames near Reading. *J. Fish Biol.*, 3: 157 - 180.

Melard Ch., Philippart J. C., 1984: Essai d'elevage semi-intensif en bassin d'alevins de perche fluviatile (Perca fluviatilis) obtenus par reproduction artificielle. *Cah. d'Ethol. appliquée*, 4: 59 - 66.

Menshutkin V. V., Zhakov L. A., 1964: Opyt matematicheskogo opredeleniya kharaktera dinamiki chislennosti okunya v zadannykh ekologicheskikh usloviyakh. In: Nikolayev I. I., Popov E. A., (eds.): Ozera Karelskogo peresheyka. Nauka, Moscow, Leningrad: 140 - 155.

Menshutkin V. V., Zhakov L. A., Umnov A. A., 1968: Issledovaniya prichin smertnosti molodi okunya metodom modelirovaniya. *Voprosy ichtiol.*, 8: 881 - 891.

Mills E. L., Forney J. L., 1983. Impact on Daphnia pulex of predation by young yellow perch in Oneida Lake, New York. *Trans. Amer. Fish. Soc.*, 112: 154 - 161.

Morgan N. C., et al., 1980: Secondary production. In: Le Cren E. D., Lowe-McConnell R. H., (eds.): The functioning of freshwater ecosystems. Cambridge Univ. Press, Chambridge, London: 247 - 340.

Noble R. L., 1970: Evaluation of the Miller high speed sampler for sampling yellow perch and walleye fry. *J. Fish. Res. Bd. Canada*, 27: 1033 - 1044.

Nyberg P., 1979: Production and food consumption of perch, Perca fluviatilis L. in two Swedish forest lakes. *Inst. Freshw. Res. Drottingholm*, Rept. No. 58: 140 - 157.

Pivnička K., 1979: Production of perch and roach fry in the Klíčava Reservoir. *Věst. čs. Společ. zool.*, 43: 43 - 47.

Pivnička K., 1982: Long termed study of the fish populations of the Klíčava Reservoir. *Acta Sci. Nat.*, Brno, XVI: 46 pp. Charles University, Prague, unpubl., 207 pp.

Post J. R., McQueen D. J., 1987: The impact of palnktivorous fish on the structure of a plankton community. *Freshw. Biol.*, 17: 79 - 89.

Sed P., 1988: Ontogenetický vývoj, potrava a růst plůdku okouna říčního v údolní nádrži Římov. MS Thesis, Agric. Univ., Č. Budějovice, unpubl., 60 pp.

Stach K., Kubečka J., 1990: Vodní dílo Římov - popis lokality. In: Kubečka J. (ed.): Ichthyofauna řeky Malše a nádrže Římov. Jihočeské muzeum, Č. Budějovice: 27 - 33.

Švátora M., 1981: Dynamika rybích populací v Záskalské údolní nádrži. PhD. Thesis, Charles Univ., Prague, unpubl., 173 pp.

Treasurer J. W., 1983: Estimates of egg and viable embryo production in a lacustrine perch, Perca fluviatilis. *Env. Biol. Fish.*, 8: 3 - 16.

Treasurer J. W., 1989: Mortality and production of 0+ perch, Perca fluviatilis L., in two Scottish lakes. *J. Fish Biol.*, 34: 913 - 928.

Van Densen W. L. T., Vijverberg J., 1982: The relationship between 0+ fish density, zooplankton size and the vulnerability of pikeperch to angling in Frisian Lakes. *Hydrobiologia*, 95: 321 - 336.

Viljanen M., Holopainen I. J., 1982: Population density of perch (Perca fluviatilis L.) at egg, larval and adult stages in the dys-oligotrophic Lake Suomunjärvi, Finland. Ann. Zool. Fennici, 19: 39 - 46.

Whiteside M. C., Swindoll M. C., Doolittle W. L., 1985: Factors affecting the early life history of yellow perch, Perca flavescens. *Envir. Biol. Fish.*, 12: 47 - 56.

Záleský A., 1986: Plodnost okouna říčního (Perca fluviatilis, Linnaeus, 1758) na Klíčavské údolní nádrži v letech 1982 - 1985 a v Záskalské nádrži a Václavském rybníku v letech 1977 - 1978. MS Thesis, Charles Univ., Prague, unpubl., 107 pp.

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THREE NEW SPECIES OF PSEUDACHORUTINI (COLLEMBOLA: NEANURIDAE)

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A b s t r a c t. Two new *Pseudachorutes* and one new *Granaurida* species from Sibiria and Canada ar described: *Pseudachorutes columbicus* sp. n. (Canada, British Columbia), *Pseudachorutes sibiricus* sp. n. (USSR, Sibiria) and *Granaurida baicalica* sp. n. (USSR, Sibiria).

During studies of a rich material of representatives of the tribe Pseudachorutini some new taxa were discovered. Two new *Pseudachorutes* and one new *Granaurida* species are described in the present contribution.

Pseudachorutes columbicus sp. n.

(Figs. 1 - 3)

D i a g n o s i s : Body 0.7 μm long, blue. Antennal segment IV with undivided apical papilla and five thickened, relatively short sensillae. Mandible with three teeth, maxilla with one needle-like lamella and with two minute apical teeth on the second one. Postantennal organ with 6 - 7 peripheral vesicles arround circular base. Seta a[illegible] missing on metanotum. Tibiotarsus with one dorsal knobed tenent hair, claw with minute inner tooth. Dens with six setae. Mucro straight, with large dorsal lamella.

D e s c r i p t i o n: Body thickset, 680 μm long and 215 μm wide, blue. Integument coarse granulated, secondary granules 2 - 3 μm in diameter. Setae 10 - 18 μm long, sensillae thin, 12 - 18 μm long. Chaetotaxy (Figs. 1A, B) as in following formula:

	I	II	III	I	II	III	IV	V
a	-	10	8^2	6^3	6	6	8	6
m	8	2^1	2	2^1	2	2	2^4	-
p	-	10	10	10	10	10	10	6
pl	1	2	3	2	2	2	5	2

1. m4 present, 2. a2 missing, 3. a2 and a4 missing, 4. m4 transfered into p-row

Head with unpaired d1 and a0 chaetae (Fig. 1A).

Lateral sensilla s on meso- and metanotum thin, 14 μm long. Sensory peg s' only on mesonotum present. Sensillae p3 on meso- and metanotum and p4 on abdominal tergites I - V not well differentiated from common setae.

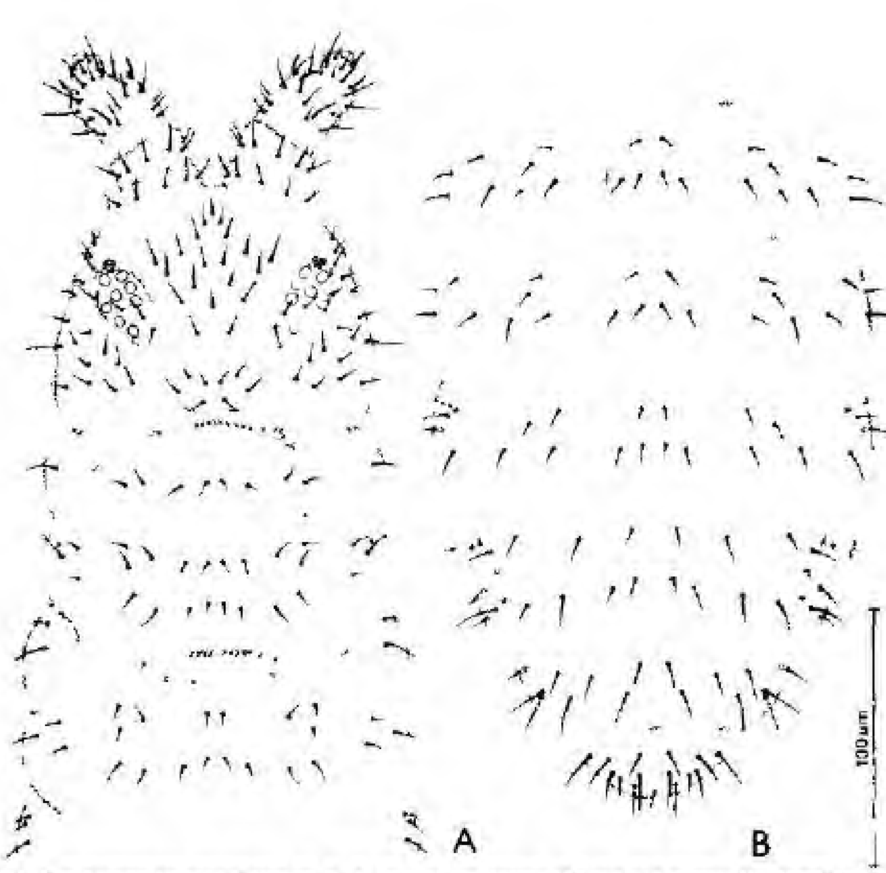

Fig. 1 Pseudachorutes columbicus sp. n. A - dorsal chaetotaxy of head and thorax; B - dorsal chaetotaxy of abdominal segments I - VI. Scale A, B - 100 µm

Antennae shorter than head, as 90 : 130 µm. Antennal segment IV with five thickened sensillae and with undivided apical papilla (Fig. 2A). Antennal organ III (Fig. 2A) consists of two long sensillae, two bent sensory pegs between them and further sensory peg ventrally.

Labrum prolonged in a short rostrum. Labral chaetotaxy 4/3322 (Fig. 2D). Labium with acuminate apex, chaetotaxy as in Fig. 2B. Mandible with three teeth (Fig. 3C), maxilla with two lamellae, one is needle-like, the second one with two minute apical teeth (Fig 3B).

Postantennal organ with circular base, 4 µm in diameter and with 6 - 7 peripheral vesicles (Fig 3E). 8 - 8 eyes, 5 - 6 µm in diameter (Fig. 2C).

Tibiotarsus with one dorsal knobed tenent hair, 38 µm long. Claw 30 µm long, with one small inner tooth.

Ventral tube with 4 + 4 setae (Fig. 3A). Retinaculum with 3 + 3 teeth and without setae. Furca well developed (Figs. 3A, D). Mucro straight (Fig. 3D), dens with six setae and coarse granules dorsally (Fig. 3D). Manubrium: dens: mucro as 60:25:10 µm.

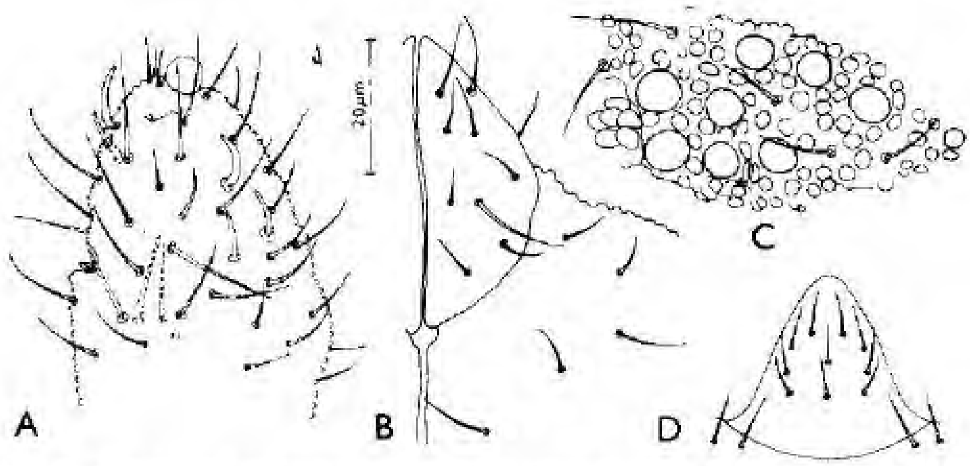

Fig. 2. *Pseudachorutes columbicus* sp. n. A - dorsal chaetotaxy of antennal segments III and IV; B - left part of labium; C - eyes and postantennal organ; D - labrum. Scale: A - D - 20 µm.

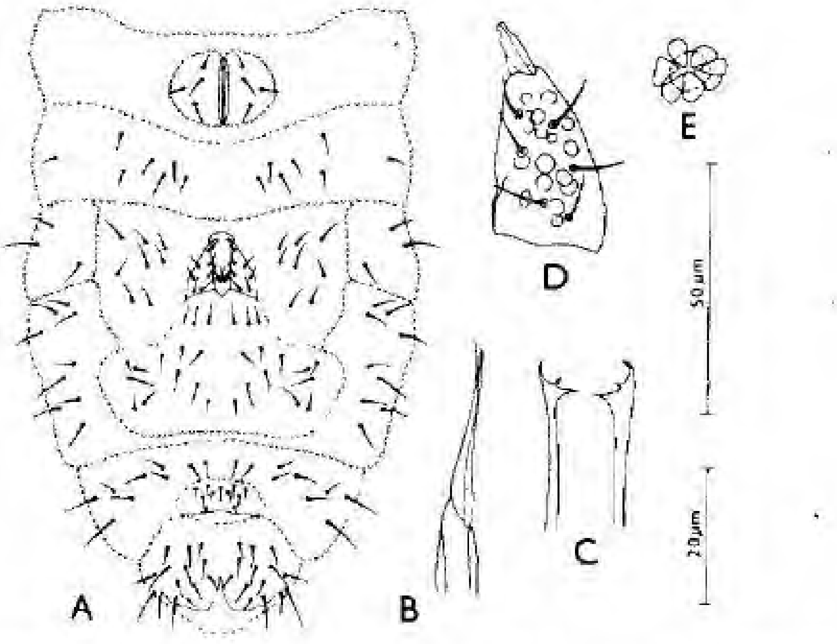

Fig. 3. *Pseudachorutes columbicus* sp. n. A - ventral chaetotaxy of abdominal segments I - VI; B - maxilla; C - mandibles; D - dorsal side of dens and mucro; E - postantennal organ. Scales: A - 50 µm; B - E - 20 µm.

V a r i a b i l i t y : Variability of chaetotaxy was studied in ten specimens. Symmetrical variability (the same seta missing on both sides of the segment) was observed in three specimens: in one male was missing m2 on pronotum and p1 on abdominal tergite IV, in other a4 on abdominal tergite III, and in one female p2 on meso- and a2 on metanotum. Asymmetrically missing setae were observed in the mentioned specimens with symmetrical variability and in three other specimens: m2 on pronotum (ones on left and twice on right sides); a4 (once on left and right sides), and a2 (once on right side) on mesonotum; a1 (once on right side) and p2 (once on right side) on metanotum; a1 (once on left side) on abdominal tergite IV.

A f f i n i t i e s : The new species is related to *Pseudachorutes corticicolus* (Schäffer, 1896). They differ clearly by the mandibles with two teeth, missing m4 seta on abdominal tergite IV and by the larger body (1.2 mm) in *P. corticicolus*. There are five thickened sensillae on antennal segment IV in *P. corticicolus*, too, but they are much longer and slender than in *P. columbicus* sp. n.

H o l o t y p e No. 9. 10. 1974/C-36 in the collection of the Pacific Forest Research Centre, Victoria, B. C., Canada, paratypes in author's collection in the Institute of Soil Biology, Czechoslovak Academy of Sciences, České Budějovice.

L o c u s t y p i c u s : Canada, British Columbia, Vancouver Island, Victoria, John Dean Park, sample of bark and rotten wood from a dry Douglas fir log in a forest stand, 9. 10. 1974 384 specimens, J. Rusek leg..

D e r i v a t i o n o m i n i s : The name is derived from the terra typica, British Columbia.

Pseudachorutes sibiricus sp. n.
(Figs. 4, 5)

D i a g n o s i s : Body 0.9 mm long, blue. Antennal segment IV with trilobed apical papilla and five long, thickened sensillae. Mandible with two teeth, maxilla with one needle-like lamella and with two minute apical teeth on the second one. Postantennal organ with 19 narrow peripheral vesicles arround circular base. Meso- and metanotum with setae a2 and m4. Tibiotarsus without knobed tenent hairs, claw with large inner tooth. Dens with six setae. Mucro straight, with low lamella.

D e s c r i p t i o n . Body thickset, 940 μm long and 260 μm wide, blue. Integument coarse granulated, secondary granules 2 - 3 μm in diameter. Setae 12 - 18 μm long, sensillae thin, 30 - 40 μm long. Chaetotaxy (Figs. 4A, 5A) as in following formula:

	I	II	III	I	II	III	IV	V
a	-	10	10	8^2	8	8	8	6
m	8	2^1	2	-	-	-	-	-
p	-	10	10	10	10	10	10	6
pl	1	2	2	2	2	2	5	2

1. m4 present, 2. a2 missing

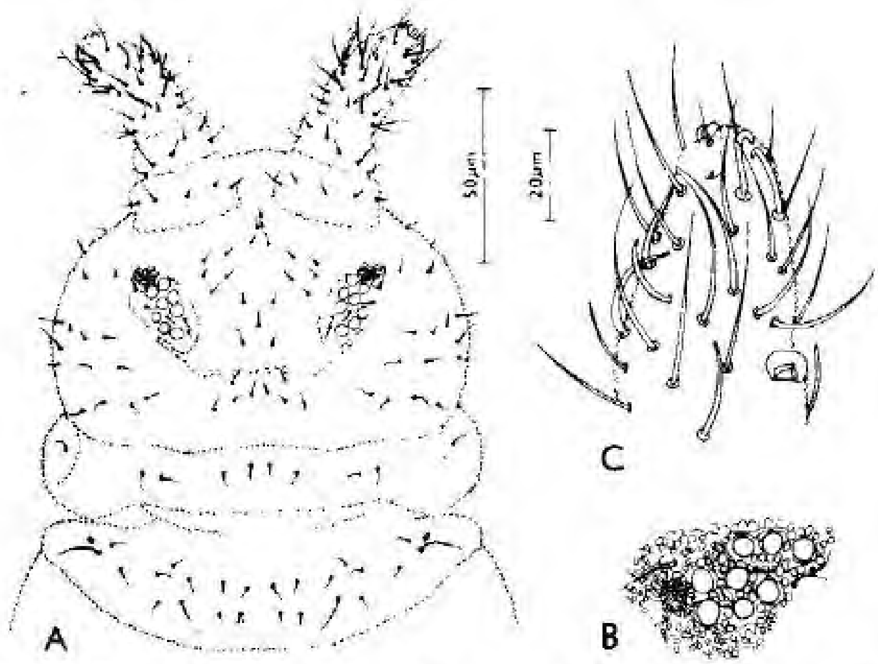

Fig. 4. *Pseudachorutes sibiricus* sp. n. A - dorsal chaetotaxy of haed, pro- and mesonotum; B - postantennal organ and eyes; B - dorsal chaetotaxy of antennal segments III and IV. Scales: A - 50 µm; B, C - 20 µm.

Head with unpaired medial seta d1 and a0 (Fig. 4A).

Lateral sensilla s on meso- and metanotum thin, 30 µm long (Fig. 4A). Sensory rods only on mesonotum present, 3 µm long. p3 on meso- and metanotum and p4 on abdominal terqites I-V are thin sensillae. Antennae shorter than head, as 170 : 200 µm. Antennal segments I:II:III:IV as 40:30:40:60 µm. Antennal segment IV with five thickened, long and bent sensillae (Fig. 4C) and with trilobed apical papilla. Antennal organ III (Fig. 4C) consists of two long sensillae, two bent sensory pegs between them and one further sensory peg ventrally.

Labrum prolonged in a short rostrum. Labral chaetotaxy 4/3322. Labium with rounded apex, its chaetotaxy as in Fig. 5D. Mandible with two teeth, maxilla with one needle-like lamella and with two minute apical teeth on the second one (Fig. 5F).

Postantennal organ with circular or slightly elliptical base 10 µm in diameter and 19 narrow peripheral vesicles (Fig. 4B). 8 + 8 eyes.

Tibiotarsi without knobed tenent hairs (Fig. 5B). Claw 40 µm long, with one large inner tooth (Fig. 5B).

Ventral tube with 4 + 4 setae. Retinaculum with 3 + 3 teeth and without setae. Furca well developed (Fig. 5C). Mucro straight (Fig. 5B). Dens with six setae and coarse granulation (Fig. 5C). Manubrium : dens : mucro as 30 : 30 : 12 µm.

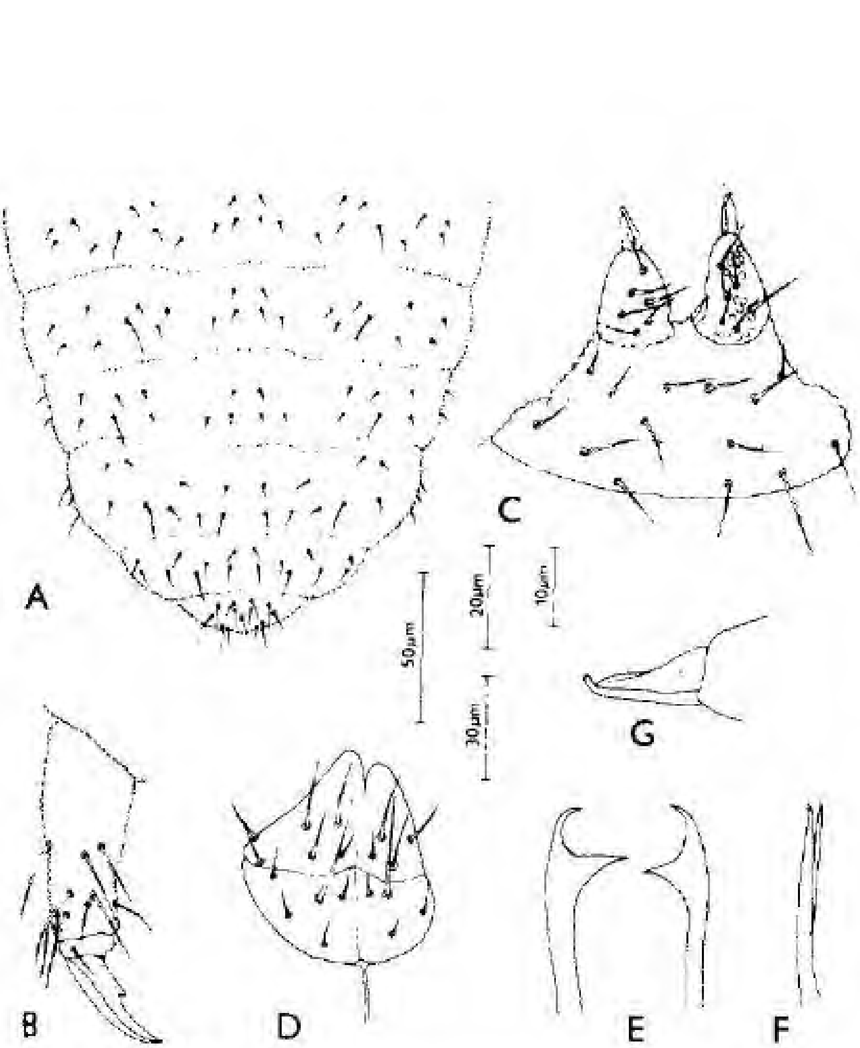

Fig. 5. *Pseudachorutes sibiricus* sp. n. A - dorsal chaetotaxy of abdominal segments I - VI; B - tibiotarsus and claw III; C - dorsal chaetotaxy of furca; D - chaetotaxy of labium; E - mandibles; F - maxilla; G - mucro. Scales: A - 50 µm; B - 30 µm; C, D - 20 µm; E - G - 10 µm.

Affinities: The new species is related to *Pseudachorutes dubius* Krausbauer, 1898. They differ clearly in the chaetotaxy of meso- and metanotum. Setae a2 and a4 are missing on meso- and metanotum in *P. dubius*.

Holotype No. 24. 5. 1973/A-219 and paratypes in author's collection, Institute of Soil Biology, Czechoslovak Academy of Sciences, Č. Budějovice.

Locus typicus: USSR, Sibiria, at the 64th km of the road from Irkutsk to Kultuk, in soil sample from a birch taiga with sparse trees of *Pinus cembra*, *Abies* sp. and *Populus* sp. and with grasses, *Vaccinium myrtillus* and mosses in understory, moist, 24. 5. 1973, 7 specimens, J. Rusek leg.

Further localities: USSR, Sibiria, at the 64th km of the road from Irkutsk to Kultuk, in sample of wet mosses and lichens with 3 - 5 cm deep layer of black microarthropode moder from north face

of a rock outcrop in a *Pinus cembra* stand, 24. 5. 1973 one specimen, J. Rusek leg.; - USSR, Sibiria, at the 64th km of the road from Irkutsk to Kultuk, in sample of litter and swampy soil from an aspen taiga with sparse birches and *Pinus cembra*, 24. 5. 1973 five specimens, J. Rusek leg.; - USSR, Sibiria, at the 64th km of the road from Irkutsk to Kultuk, in sample of needle-litter and black moder from taiga dominated by *Pinus cembra* and *Pinus sibirica* with sparse birches and with *Vaccinium myrtillus* and mosses in understory, moist, 24. 5. 1973 one specimen, J. Rusek leg.

Derivatio nominis: The name of the new species is derived from the terra typica.

Grananurida baicalica sp. n.

(Figs. 6 - 8)

Diagnosis: Body 0.9 mm long, pale yellow. Antennal segment IV with undivided apical papilla and five thickened sensillae. Mandible with three teeth, maxilla with two needle-like lamellae. Postantennal organ circular, with 20 vesicles arranged in a morula. Meso- and metanotum without m4 seta. Tibiotarsi without knobed tenent hairs, claw with one inner tooth. Ventral tube with 4 + 4 setae. Furca strongly reduced into a round papilla with 4 + 4 setae.

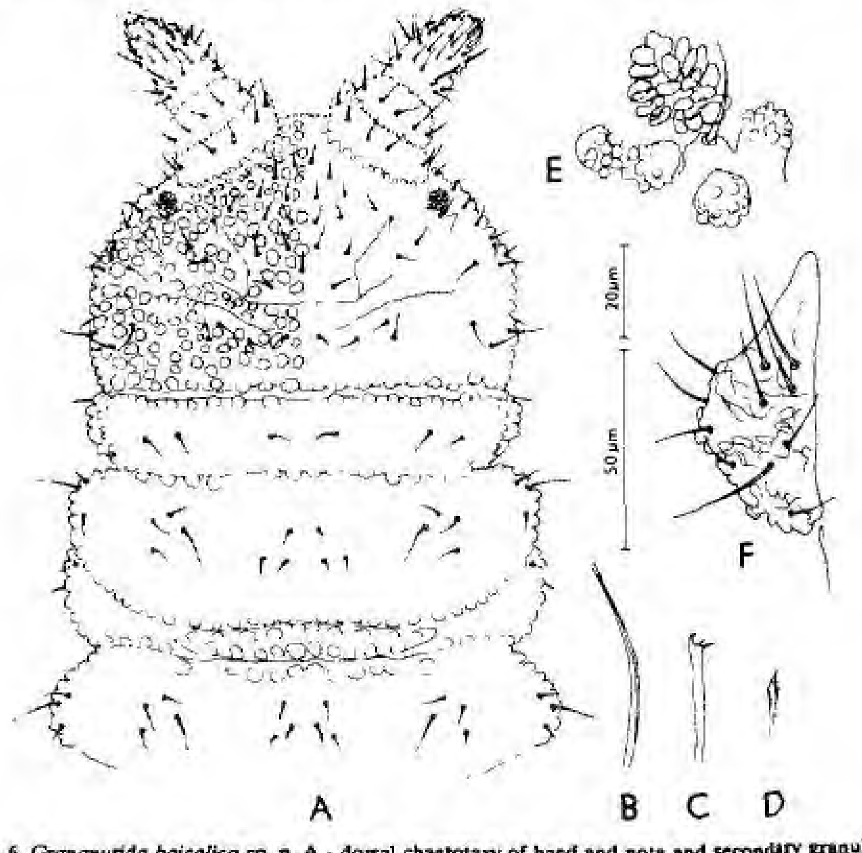

Fig. 6. *Grananurida baicalica* sp. n. A - dorsal chaetotaxy of haed and nota and secondary granules on left half of haed; B - maxilla; C - mandible; D - lamella of hypopharynx; E - postantennal organ and secondary granules; F - left part of labium. Scales: A - 50 µm; B - E - 20 µm.

D e s c r i p t i o n : Body thickset (Figs. 6A, 7A), 900 μm long and 340 μm wide. Pale yellow, with sparse grains of dark pigment. Integument very coarse granulated (Figs. 6A, E, 7D), secondary granules 8 - 10 μm in diameter, on some body parts exceptionally smaller. Setae 15 - 17 μm long, not differentiated into macrochaetae, sensillae 30 - 35 μm long.

Chaetotaxy as in following formula (Figs. 6A, 7A):

	I	II	III	I	II	III	IV	V
a	-	8	8	6^2	6	6	8^4	6
m	6	-	-	-	-	-	-	-
p	-	10^1	10	10^3	10	10	10	8
pl	1	2	2	2	2	3	3	2

1. p3 is sensilla, 2. a2 and a4 missing, 3. p4 is sensilla, 4. a2 missing

Head with unpaired medial d1 seta (Fig. 6A).

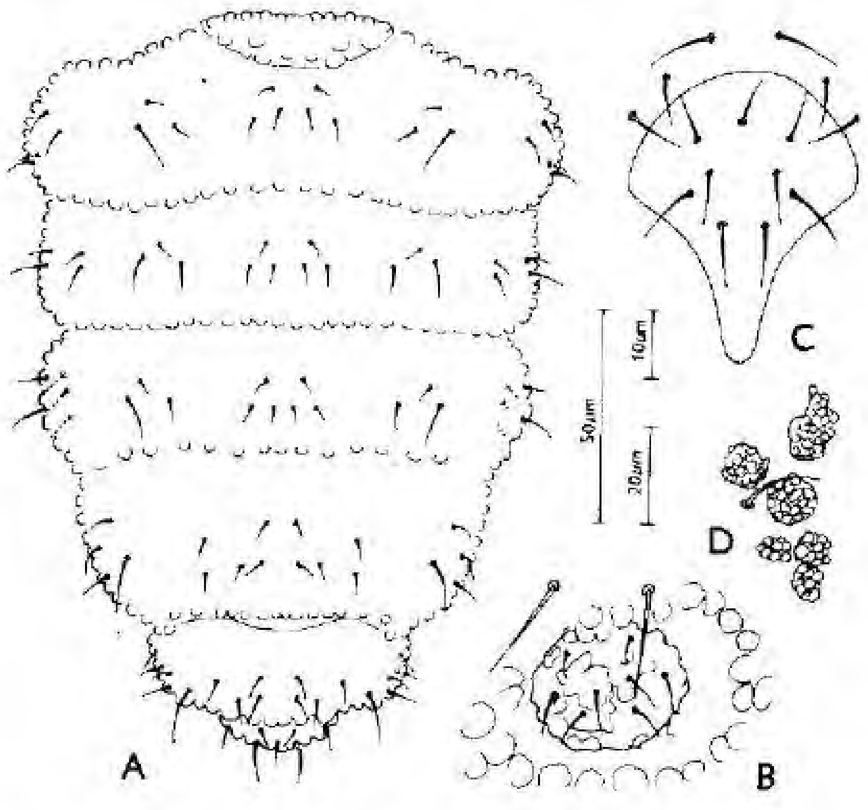

Fig. 7. *Grananurida baicalica* sp. n. A - dorsal chaetotaxy of abdominal segments I - VI; B - rest of reduced furca; C - labrum; D - secondary granules on haed. Scales: A - 50 μm; B - 20 μm; C, D - 10 μm.

Lateral sensilla s on meso- and metanotum thin, 33 μm long. Sensory pegs present only on mesonotum, 2.5 μm long.

Antennae shorter than head, as 120 :190 μm. Antenal segments I : II : III : IV as 30 : 25 : 20 : 45 μm. Antennal segment IV with five thickened sensillae and undivided apical papilla (Fig. 8A). Antennal organ III (Fig. 8A) consists of two long sensillae, two small sensory pegs between them and one sensory peg ventrally.

Labrum prolonged to short rostrum. Labral chaetotaxy (Fig. 7C) 6/3 4 2. Labium with acuminate apex and chaetotaxy as in Fig. 6F. Mandible with three teeth (Fig. 6C), maxilla needle-like. Hypopharynx with franged, thin lamella (Fig. 6D). Without eyes. Postantennal organ circular, 8 μm in diameter, with 20 vesicles arranged in a morula (Fig. 6E).

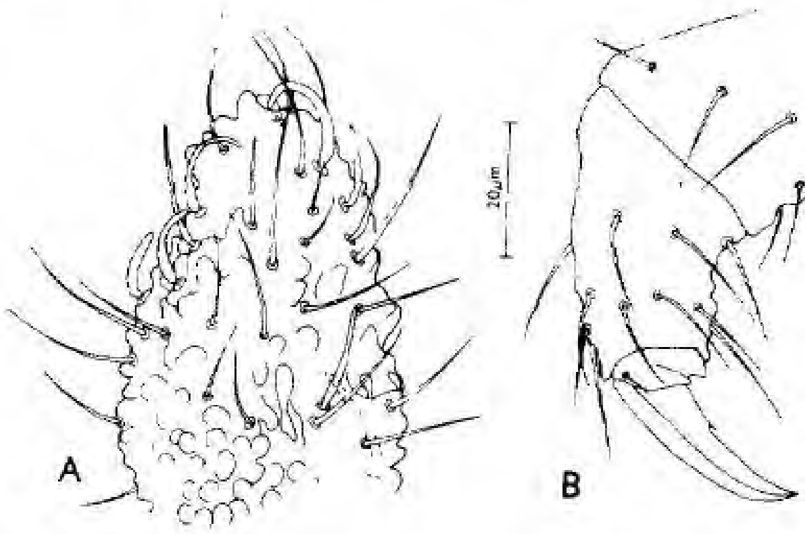

Fig. 8. *Grananurida baicalica* sp. n. A - dorsal chaetotaxy of antennal segments III and IV; B - apical part of leg III. Scale: A, B - 20 μm.

Tibiotarsus without knobed tenent hairs (Fig. 8B). Claw 30 μm long, with one inner tooth (Fig. 8B). Ventral tube with 4 + 4 setae. Retinaculum missing. Furca reduced to a circular papilla, 23 μm in diameter, with 4 + 4 short setae (Fig. 7B).

A f f i n i t i e s : The new species differs from the only known representative of the genus *Grananurida tuberculata* Yosii, 1954 by longer sensillae on antennal segment IV, especially a and c, missing seta m4 on mesonotum and by presence of 4 + 4 setae on ventral tube. There are some other differences between these two species, as for instance longer setae (e. g. on labium), constant three teeth on mandible and shorter body in the new species, but it should be prooved how constant are those characters in *G. tuberculata*.

H o l o t y p e No. 23. 5. 1973/A-207 and paratypes in author's collection, Institute of Soil Biology, Czechoslovak Academy of Sciences, Č. Budějovice.

L o c u s t y p i c u s : USSR, Sibiria, near the road Irkutsk - Bajkal Lake, 10 km north of Bolshaia Riechka village, on W slope near Angara River. Sandy soil sample from a willow stand with sparse grasses in understory, 23. 5. 1973 six specimens, J. Rusek leg.

F u r t h e r l o c a l i t i e s : USSR, Sibiria, Listvjanka village on the NO coast of Bajkal Lake. Humus sample (20 cm deep) from a birch tajga (with sparse pines) with rich understory of *Ledum palustre, Rhododendron dahuricum, Vaccinium* sp., *Rosa* sp., mosses and lichens; mesic conditions, moderate W slope, 23. 5. 1973 one specimen, J. Rusek leg.; - USSR, Sibiria, at the 64 km of the road from Irkutsk to Kultuk, ranker soil sample covered with lichens and needle litter from the top of a rocky hill with sparse *Pinus cembra* stand, 24. 5. 1973 two specimens, J. Rusek leg.; - USSR, Sibiria, at the 64 km of the road from Irkutsk to Kultuk, soil sample from a meadow dominated by grasses, *Alchemilla* sp., *Plantago* sp. and mosses, cambisol, 24. 5. 1973 one specimen, J. Rusek leg.; - USSR Sibiria, at the 64 km of the road from Irkutsk to Kultuk, sample of soil covered by 1 cm deep layer of needle litter, from a pine tajga dominated by *Pinus cembra, Pinus sibirica* and *P. sylvatica* and with birches, *Vaccinium myrtillus, Rosa sp.* and mosses in understory, 24. 5. 1973 one specimen, J. Rusek leg.

D e r i v a t i o n o m i n i s : The name of the new species is derived from the Baikal Lake.

REFERENCES

C h r i s t i a n s e n K. A. and B e l l i n g e r P. F., 1980: The Collembola of the North America north of the Rio Grande. I. Poduridae & Hypogastruridae. Grinnell College, Grinnel. 386 pp.

M a s s o u d Z., 1967: Monographie des Neanuridae. Collemboles poduromorphes a pièces buccales modifiées. Biol. Amer. Austr. CNRS, Paris, 3 : 7 - 399.

S t a c h J., 1949: The Apterygotan fauna of Poland in relation to the world-fauna of this group of insects. Families: Anuridae and Pseudachorutidae. *Acta monogr. Mus. Hist. nat. Kraków*, 122pp + 15 plts.

W e i n e r W. M. and N a j t J., 1985: North Korean Collembola. V. The genus Gnananurida Yosii, 1954, *Acta zool. Cracov.*, 28: 277 - 282.

Y o s i i R., 1954: Springschwänze des Ozé-Natuschutzgebietes. *Sci. Res. Ozegahara Moor.* Tokyo, pp. 777 - 830.

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METACERCARIAE OF TREMATODES FROM FISH IN VIENTIANE PROVINCE, LAOS

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A b s t r a c t . The paper presents a systematic survey of trematode metacercariae found in 918 freshwater fish from Laos. A total of 14 species (*Bucephalopsis* sp. 1, *Bucephalopsis* sp. 2, *Encyclometra colubrimurorum*, Plagiorchiidae gen. sp., Cryptogonimidae gen. sp., *Posthodiplostomum grayi*, Prohemistomatidae gen. sp., *Opisthorchis viverrini*, *Centrocestus formosanus*, *Haplorchis pumilio*, *H. taichui*, *Stellantchasmus falcatus*, *Haplorchoides mehrai*, and metacercaria type 1) were found. All species, whose description and figures are given, have been recorded in Laos for the first time. The new host records are as follows: *Channa striata* for *E. columbrimurorum* metacercariae, *Trichopsis* sp. and *Anabas testudineus* for *P. grayi*, *Esomus longimana* for *C. formosanus* and 12 species of cyprinid fish for *H. mehrai*.

During the study on opisthorchosis carried out in Laos in 1989+), fish as potential second intermediate hosts of the trematode *Opisthorchis viverrini* (Poirier, 1886) were examined for the presence of metacercariae. In addition to *O. viverrini* larvae, metacercariae of other trematodes were found. Since no data on fish helminths in Laos are available, the present paper surveys the findings of trematode larvae in fish from Vientiane province. Material of adult trematodes found in fish from Laos is evaluated in other paper (S c h o l z 1991).

MATERIAL AND METHODS

A total of 918 fish of the following 61 species were examined (nomenclature after K o t t e l a t 1989; number of specimens in parentheses): 1. *Notopterus chitala* (Hamilt.) (2), 2. *N. notopterus* (Pall.) (5) (Notopteridae); 3. *Clupeichthys aesarnensis* Wongratana (28) (Clupeidae) 4. *Barbodes* cf. *foxi* (Fowl.) (5), 5. *B. gonionotus* (Bleek.) (47), 6. *B. schwanenfeldii* (Bleek.) (26), 7. *Cirhinus jullieni* auct. nec Sauvage (=*Henicorhynchus siamensis* Sauv.) (5), 8. *Crossocheilus* sp. (7), 9. *Cyclocheilichthys armatus* (Valenc.) (8), 10. *C. repasson* (Bleek.) (30), 11. *Cyclocheilichthys* sp. (1), 12. *Cyprinus carpio* L. (5), 13. *Esomus longimana* (Lunel) (167), 14. *Hampala dispar* Smith (114), 15. *H. macrolepidota* Kuhl et van Hasselt (36), 16. *Labiobarbus lineatus* (Sauv.) (4), 17. *Mystacoleucus marginatus* (Valenc.) (30), 18. *Osteochilus hasselti* (Valenc.) (1), 19. *O. ? microcephalus* (Valenc.) (2), 20. *Parachela oxygastroides* (Bleek.) (6), 21. *Paralaubuca* cf. *typus* Bleek. (1), 22. *Puntioplites proctozysron* (Bleek.) (5), 23. *Puntius daruphani* Smith (1), 24. *P. leiacanthus* auct. nec (Bleek) (= *P. brevis* (Bleek.) (25), 25. *P. orphoides* (Valenc.) (2), 26. *Puntius* sp. (35), 27. *Raiamas guttatus* (Day) (19), 28. *R. borapetensis* Smith (60), 29. *Rasbora daniconius* (Hamilton) (1), 30. *Xenocheilichthys* (=*Sikukia*) *gudgeri* (12), 31. Cyprinidae gen. sp. juv. (? *Puntius* sp.) (65) (Cyprinidae); 32. *Lepidocephalichthys berdmorei* (Blyth) (1), 33. *L. micropogon* (Blyth) (6) (Cobitidae); 34.,

+) The study was a part of the project „Studies on epidemiology and morbidity of some parasitic diseases in Laos" carried out on the basis of bilateral scientific-technical cooperation between Czechoslovakia and Laos

Mystus nigriceps (Valenc.) (1), 35. *M. rhegma* Fowl. (4), 36. *M. vittatus* (Bloch) (2), 37. *Mystus* sp. (2) (Bagridae); 38. *Kryptopterus cryptopterus* (Bleek.) (3), 39. *Ompok bimaculatus* (Bloch) (2) (Siluridae); 40. *Laides hexanema* (Bleek.) (1), 41. *Pangasius* sp. (4) (Pangasidae); 42. *Clarias batrachus* R. (3) (Clariidae); 43. *Xenentodon cancila* (Hamilt.) (11) (Belonidae); 44. *Doryichthys deokhatoides* (Bleek.) (1) (Syngnathidae); 45. *Monopterus albus* Zuiew (1) (Synbrachidae); 46. *Parambassis punctulata* (Fraser-Brunner) (3) (Ambassidae); 47. *Datnioides microlepis* Bleek. (1) (Lobotidae); 48. *Pristolepis fasciata* Bleek. (3) (Nandidae); 49. *Oreochromis niloticus* (L.) (5) (Cichlidae); 50. *Tukugobius* cf. *ocellatus* Fowler (8) (Gobiidae); 51. *Anabas testudineus* (Bloch) (13) (Anabantidae); 52. *Betta* cf. *smaragdina* Ladig. (3), 53. *Trichogaster pectoralis* (Reg.) (3), 54. *T. trichopterus* (Pall.) (15), 55. - 56. *Trichopsis schalleri* Ladig. and *T. vittata* (Cuv.) (19) (Belontiidae); 57. *Osphronemus goramy* Lacep. (16) (Osphronemidae); 58. *Channa striata* (Bloch) (20) (Channidae); 59. *Macrognathus siamensis* (Günth.) (4), 60. *Mastacembelus favus* Hora (5) (Mastacembelidae); 61. *Tetraodon leiurus* Bleek. (3) (Tetraodontidae).

Fish were identified according to keys and descriptions in books of S m i t h (1945) and T a k i (1974). Identification of fixed fish (211 specimens) was revised by Dr. Maurice Kottelat from Zoologische Staatssammlung, München, Germany. Fish were caught with trawl or landing net; a small part of fish originated from local fishermen. List of localities and number of fish examined is given in Table 1. The dissection of fish was concentrated to the examination of their flesh because the main aim of the study was the investigation of the occurrence of *O. viverrini* metacercariae localized nearly exclusively in muscles. Inner organs, gills and fins were examined only in a part of fish. Flesh compressed between two glasses was observed under dissecting microscope with the magnification 31 x. A part of metacercariae from each host was isolated from host tissue and identified under light microscope. Some of them were fixed under cover glass by solution of concentrated picric acid and glycerin (1 : 1) or by 4 % formalin. Larvae were measured and figured both living and fixed. Figures were made with the aid of Carl Zeiss drawing attachment. Considering incompleteness of dissection of some fish hosts, the data on the intensity of infection are omitted. All measurements given here are in milimetres.

SURVEY OF METACERCARIAE

Family B u c e p h a l i d a e Poche, 1907

1. *Bucephalopsis* sp. 1 Fig. 1 A, B

D e s c r i p t i o n : cysts from muscles oval, measuring 0.18 - 0.25 x 0.11 - 0.19, cysts from fins somewhat smaller (0.14 - 0.19 x 0.06 - 0.12). Thickness of cyst walls 0.004 - 0.018. Metacercariae mostly folded in cyst (C- or S-shaped). Space between larva and cyst walls filled in with numerous granules of two kinds. Measurements of metacercariae released from cyst 0.30 - 0.55 x 0.14 - 0.24. Their body surface covered with densely arranged, fine spines, up to 0.005 long; spines posteriorly smaller and more sparse. Anterior sucker oval, measuring 0.042 - 0.090 x 0.038 - 0.094; size of strongly muscular pharynx 0.032 - 0.049 x 0.030 - 0.046. Intestine sac-shaped, measuring 0.068 - 0.097 x 0.041 - 0.083. Excretory bladder elongated, 0.038 - 0.095 x 0.023 - 0.061 in size. Anlagen of testis and ovary weakly visible, about 0.024 - 0.035 x 0.027 - 0.030 in size. Muscular genital bursa oval, measuring 0.055 - 0.092 x 0.022 - 0.030, situated near posterior body end. Numerous elongated, transversaly situated bodies filling metacercaria, mainly its anterior part.

H o s t a n d l o c a l i t i e s (see Table 1): *Raiamas guttatus* (infected one fish; number of fish examined - see Material and Methods) - locality 2a; *Barbodes gonionotus* (3) - 2b; *Hampala dispar* (1) - 2a; *Mystacoleucus marginatus* (10) - 2a; *Puntius daruphani* (1) - 2b; *Sikukia gudgeri* (4) - 2a, 2b.

L o c a l i z a t i o n : muscles, fins.

Table 1. List of localities and number of fish examined

Locality	N° fish	Fish species +)
1. Irrigation systems of rice fields, swamps		
Vientiane municipality:		
1a. Sikhay suburb of Vientiane	19	13, 24, 28, 33, 51 52, 55, 59
1b. swamp in Samgniekchinaimo suburb	73	13, 32, 33, 53, 54, 55, 58
1c. Nong Sang Thoo suburb	37	13, 26, 28, 31
1d. Khamsavath village	98	13, 26, 28, 31, 42, 49, 51, 54, 58
1e. Nong Ping village	18	13, 31, 33, 51, 54, 55, 56
1f. That Luang suburb	14	13, 31, 51, 55 - 56
1g. Dong Naxok suburb	12	13, 28, 42, 54, 55 + 56
1h. ponds in Nong Teng village	8	12, 13
1i. canal Bung Salakham	23	13, 24, 26, 28, 51 52, 55 - 56, 58
Toulakhom *district*:		
1j. Nanin village near B. Keun	15	13, 26, 28, 54, 55 - 56, 58
Keo-Oudom district:		
1k. ponds in Thakeo village	7	58
1l. Phonmi village	86	7, 8, 10, 20, 24, 26, 28, 31
1m. canal near Naxon village	9	7, 8
1n. Phonsavath village	9	13, 20, 28
2. Rivers		
Vientiane municipality:		
2.a. Mekong in Vientiane	79	1, 5, 9, 17, 21, 27, 34, 40, 41, 42, 43, 46, 47, 50, 58, 59, 60, 61
Toulakhom district:		
2b. Nam Ngum near Nanin village	11	11, 16, 17, 22, 23, 30, 44
3. Water reservoir Nam Ngum +)	386	2, 3, 4, 5, 6, 10, 14, 15, 16, 17, 18, 19, 22, 24, 25, 26, 28, 29, 34, 35, 37, 38, 39, 41, 43, 46, 48, 55 - 56, 57, 58, 61
4. Fish market (locality unknown)	14	14, 45
Total	918	

+) List of localities at Nam Ngum water reservoir includes paper by D i t r i c h et al. (1990).

C o m m e n t s : metacercariae from Laos correspond by shape of oral sucker, excretory bladder and caecum with members of the genus *Bucephalopsis*, common parasites of marine or freshwater fish (Y a m a g u t i 1958, 1971). According to K. C. Pandey (pers. comm.), they somewhat resemble the species *B. multiglandulatus* Pandey, 1967. However, species identification of the larvae from Laos seems to be impossible.

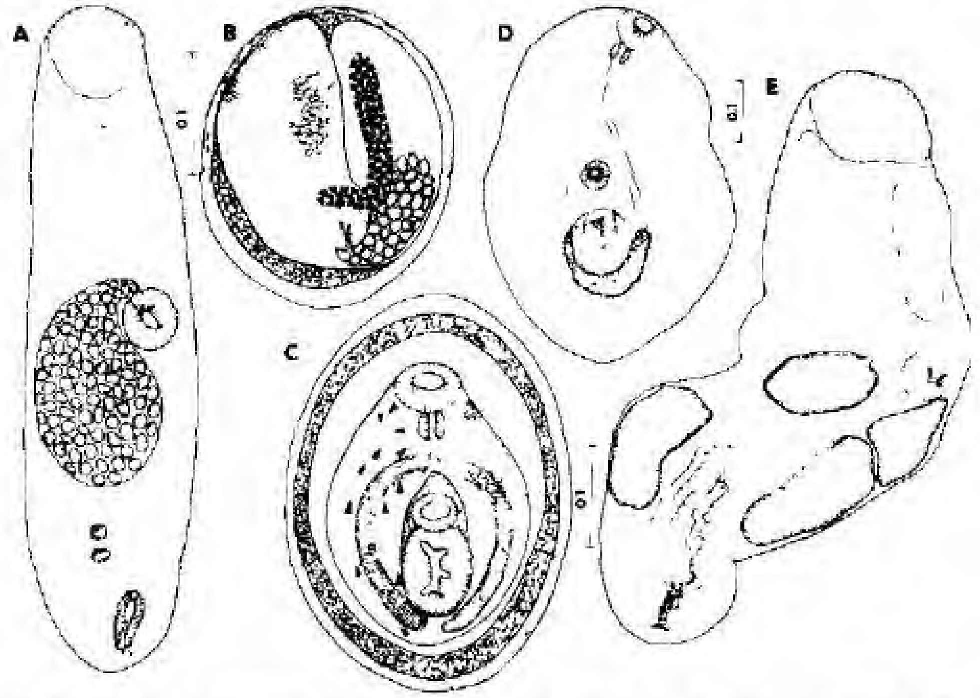

Fig. 1. A, B - *Bucephalopsis* sp. 1; C, D - Prohemistomatidae gen. sp.; E - *Bucephalopsis* sp. 2. A, D, E - excysted metacercaria; B, C - encysted metacercaria.

2. *Bucephalopsis* sp. 2 Fig. 1E

D e s c r i p t i o n (after 1 fixed specimen): metacercaria was found free, nonencysted, its measurements 0.67 x 0.22. Anterior sucker large, rhynchus-like, strongly muscular, 0.095 x 0.135 in diameter. Pharynx almost rounded, 0.058 x 0.046 in diameter. Intestine sac-shaped, measuring 0.116 x 0.068. Ovary anlage situated immediately behind pharynx, 0.116 x 0.058 in size. Anlagen of vitellaria elongated, localized behind anterior sucker near lateral body margin, 0.135 - 0.160 x 0.035 - 0.045 in size. Two testis anlagen situated laterally behind caecum and ovary anlage, measuring 0.135 - 0.155 x 0.058 - 0.065. Genital bursa muscular, 0.114 x 0.053 in diameter.

H o s t a n d l o c a l i t y : *Barbodes gonionotus* (1) - 3.

L o c a l i z a t i o n : muscles of pectoral fin.

Comments: morphology of the specimen indicates that it also belongs to the genus *Bucephalopsis*. Of the species described or figured in papers of Yamaguti (1971, 1975), Chen Chin-leu (1973), Tang and Tang (1976), Wang (1985), Bykhovskaya-Pavlovskaya and Kulakova (1987) and Moravec and Sey (1989), metacercaria under study is morphologically very similar to *B. rhynchobati* Wang, 1985. This species, parasitic in *Rhynchobatus djidensis* in Fujian Province (China), has similarly rhynchus-like anterior sucker, vitellaria in front of caecum, ovary and pharynx at the same level and testes obliquely one after other (Wang 1985). The species *B. sibi* Yamaguti, 1940, provided also with similar anterior sucker, differs by more posterior localization of vitellaria. They are situated along caecum and reach to anterior margin of testis. Moreover, this species was found in marine fish (Yamaguti 1971).

Family Plagiorchidae Ward, 1917

3. *Encyclometra colubrimurorum* (Rudolphi, 1819) Fig. 2 C

Description (after one living, excysted specimen): large, leaf-shaped metacercaria measuring 1.50 x 0.72. Oral sucker nearly rounded, 0.21 x 0.27 in diameter. Rounded ventral sucker measuring 0.24 - 0.25. Prepharynx and oesophagus short (both 0.03 long), pharynx rounded, measuring 0.095 - 0.103. Intestinal caeca very long, reaching almost to posterior extremity. About forty small, drop-shaped glands localized around pharynx and behind intestine bifurcation, connected by narrow ducts to several groups of 2 - 6 glands. Anlage of cirrus sac situated near anterior margin of oral sucker. Excretory bladder large, lobate, forming about 8 lateral branches.

Host and locality: *Channa striata* (1) - 1 k.

Localization: muscles

Comments: the morphological features of the metacercaria are identical with those of trematodes of the genus *Encyclometra* Baylis et Cannon, 1924, adults of which are intestinal parasites of snakes; encysted metacercariae are found in flesh of frogs and some fish as *Macropodus opercularis* and *Misgurnus anguillicaudatus* (Chiang 1951, Yamaguti 1971, 1975). Out of several species described, only three or four are considered to be valid (Yeh 1958, Dollfus 1963, Gupta and Mehrotra 1977). The equal length of intestinal caeca, presence of prepharynx and oesophagus of metacercaria from Laos indicate that the specimen belongs to the species *E. colubrimurorum*.

Adults of this species are common parasites of snakes in Europe and Asia (Yamaguti 1971). Adults of *E. colubrimurorum* designated erroneously as *E. caudata* (Polonio, 1859) (see Dollfus 1963) were found in Vietnam by Joyeux and Houdemer (1928).

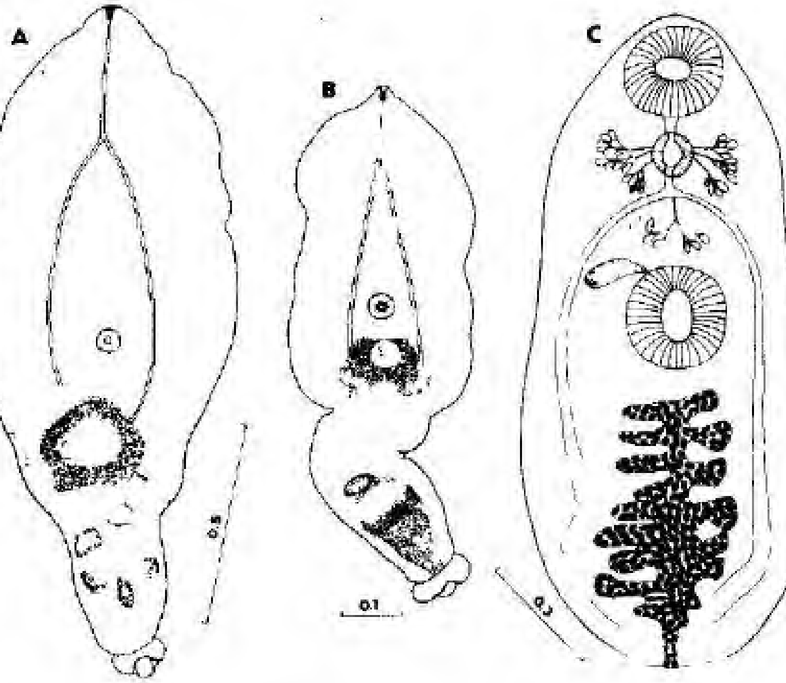

Fig. 2. A, B - *Posthodiplostomum grayi* (Verma, 1936); C - *Encyclometra colubrimurorum* (Rudolphi, 1819). A, B, C - excysted metacercariae.

4. Plagiorchiidae gen. sp. (? spp.) Fig. 3

D e s c r i p t i o n : cysts mostly rounded, 0.16 - 0.30 x 0.15 - 0.26 in diameter. Thickness of cyst wall rather variable, ranging from 0.004 do 0.038. Metacercaria in cyst mostly folded, C-shaped, measuring after liberating from cyst 0.27 - 0.55 x 0.11 - 0.20. Surface of body covered with transverse rows of spines. Anteriormost spines (6 - 8 rows) large, up to 0.005 long; backward spines becoming considerably finer and less densely arranged. Oral sucker nearly rounded, 0.046 - 0.076 x 0.049 - 0.030 in size. Ventral sucker relatively small, 0.030 - 0.049 x 0.033 - 0.050 in size. Prepharynx, if present, short (length 0.003 - 0.022). Pharynx large, strongly muscular, 0.020 - 0.0455 x 0.027 - 0.052 in diameter. Oesophagus 0.023 - 0.103 long; intestinal caeca wide, not reaching anterior margin of excretory bladder, measuring 0.065 - 0.155 x 0.018 - 0.039. Hardly visible ovary anlage median or submedian, behind ventral sucker. Two testis anlagen situated between intestinal caeca and anterolateral margin of excretory bladder, 0.015 - 0.023 x 0.023 - 0.031 in size. Cirrus sac anlage surrounding ventral sucker. Excretory bladder sac-shaped, sometimes almost Y-shaped, with short and wide anterior branches. Size of bladder 0.057 - 0.099 x 0.038 - 0.141. Number of flame cells estimated to be about 2 x 15 = 30.

Hosts and localities: *Esomus longimana* (32) - 1c, 1d, 1e, 1f, 1g, 1h, 1i; *Puntius* sp. juv. (1) - 1d; *Rasbora borapetensis* (2) - 1d; Cyprinidae gen. sp. juv. (6) - 1d,. 1e, 1i; *Anabas testudineus* (2) - 1d, 1e; *Trichogaster trichopterus* (1) - 1f; *Trichopsis* sp. (1) - 1i; *Channa striata* (1) - 1d.
Localization: muscles
Comments: specimens studied belong to the family Plagiorchiidae Ward, 1917 (Yamaguti 1971, 1975), probably to the genera *Plagiorchis* or *Tremiorchis*. Differences in caecum length and shape of excretory bladder indicate that the presence of two species in material studied cannot be excluded. However, their separation and correct specific identification is not possible until the life cycle is elucidated.

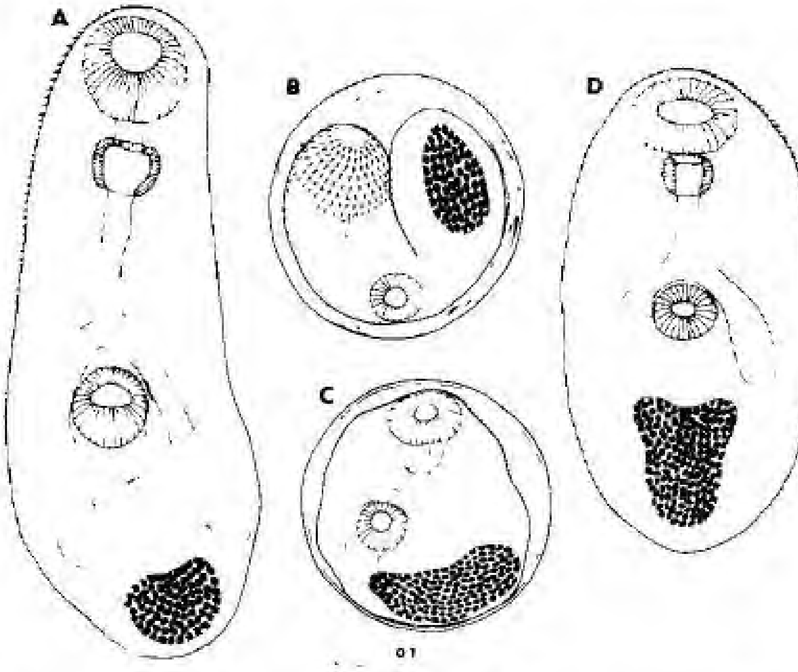

Fig. 3. Plagiorchiidae gen. sp.; A, D - excysted metacercaria; B, C - encysted metacercaria.

Family Cryptogonimidae Ciurea, 1933

5. Cryptogonimidae gen. sp. Fig. 4 E, F

Description (after one fixed specimen): metacercaria measuring 0.42 x 0.35 surrounded by partly damaged, transparent inner cyst wall. Body surface covered with numerous, densely arranged spines, visible only in anterior third of body. Rounded oral sucker 0.074 x 0.080 in diameter, armed with circumoral row of 28 simple spines, measuring 0.010 - 0.011 x 0.003. Small ventral sucker oval, measuring 0.030 x 0.026. Prepharynx short (0.013), pharynx nearly rounded, 0.023 x 0.022 in diameter. Excretory bladder weakly visible, probably oval.

H o s t a n d l o c a l i t y : *Sikukia gudgeri* (1) - 2b
L o c a l i z a t i o n : anal fin.

C o m m e n t s : metacercaria was found in fixed specimen of *S. gudgeri*. Therefore, many morphological details visible in living metacercariae have not been recognizable. Nevertheless, the presence of single row of circumoral spines on large oral sucker, very short prepharynx and small ventral sucker situated in middle body region of metacercaria indicate that it belongs to the family Cryptogonimidae Ciurea, 1933 sensu Yamaguti (1971). The metacercaria under study is morphologically very similar to members of the genus *Ryjikovia* Gaevskaya et Aleshkina, 1985. However, all hitherto described species of this genus parasitize exclusively marine fish (G a e v s k a y a et A l e s h k i n a 1985). Nevertheless, the occurrence of some *Ryjikovia* species in freshwater fish cannot be excluded because many trematodes of the family Cryptogonimidae, e. g. *Cryptogonimus, Centrovarium, Neochasmus, Allacanthochasmus)* are common parasites of freshwater fish (Y a m a g u t i 1971).

Family D i p l o s t o m a t i d a e Poirier, 1886

6. *Posthodiplostomum grayi* (Verma, 1936) Fig. 2 A, B

D e s c r i p t i o n (after two stained specimens): metacercariae measuring 0.88 - 1.68 x 0.30 - 0.66 were found free in host tissue. Body divided in two parts. Leaf-shaped forebody measuring 0.52 - 1.28 x 0.30 - 0.66; hindbody considerably narrower, 0.36 - 0.40 x 0.17 - 0.23 in size, provided with collar-like bursa copulatrix surrounding genital cone. Size of bursa 0.045 - 0.075 x 0.119 - 0.141. Body surface covered with fine, very densely arranged spines. Rounded oral sucker small (0.023 - 0.031 x 0.024 - 0.027); ventral sucker 0.041 - 0.077 x 0.044 - 0.071 in diameter. Prepharynx very short (0.005 - 0.008); pharynx small, measuring 0.016 - 0.027 x 0.011 - 0.016. Oesophagus 0.06 - 0.30 long. Holdfast organ large, 0.083 - 0.141 x 0.106 - 0.160 in size, situated at the end of hindbody. Ovary anlage pretesticular, submedian. Anlagen of other genitalia filling a large part of hindbody.

H o s t s a n d l o c a l i t i e s : *Anabas testudineus* (1) - 1i; *Trichopsis* sp. (1) - 1i.
L o c a l i z a t i o n : muscles.

C o m m e n t s : the morphology of the specimens from Laos indicates that they belong to the genus *Posthodiplostomum* Dubois, 1936. The trematodes of this genus are common parasites of fish-eating birds; their metacercariae are found in many species of freshwater fish in America, Europe, Africa, Asia and Australia (Y a m a g u t i 1971, B y k h o v s k a y a - P a v l o v s k a y a and K u l a k o v a 1987). In Japan, metacercariae of *P. podicipitis* (Yamaguti, 1939) were recorded in perciform fish *Oryzias latipes* - Y a m a g u t i (1971). Adults of other five species, *P. cheni* (Yang, 1959), *P. duboisi* Rao, 1957, *P. grayii* (Verma, 1936), *P. larai* (Refuerro et Garcia, 1937) and *P. suni* Lee, 1969, were found in birds from Southeast Asia (Y a n g 1959, Y a m a g u t i 1971).

Specimens under study are morphological very similar to those of the species *Mesoophorodiplostomum (=Posthodiplostomum) cheni* Yang, 1959 (Y a n g 1959). However, D u b o i s (1964) considered *P. cheni* and *P. larai* to be synonyms of *P. grayi*,

a common parasite occurring in India, Philippines and China. Consequently, we designate two metacercariae from *A. testudineus* and *Trichopsis* sp. as *P. grayi*.

Family Prohemistomatidae Sudarikov, 1961

7. Prohemistomatidae gen. sp. Fig. 1 C,D

Description: thick-walled cysts oval, measuring 0.36 - 0.41 x 0.30 - 0.38. Thickness of outer cyst wall about 0.020, of inner wall 0.035 - 0.040. Metacercaria oval, not folded in cyst, measuring after liberating from cyst 0.24 - 0.48 x 0.14 - 0.35. Three fourth of body surface covered with fine, dense spines, up to 0.003 long. Spines becoming shorter and thinner posteriorly. Oral sucker oval, 0.036 - 0.072 x 0.043 - 0.076 in size; ventral sucker 00.036 - 0.049 x 0.038 - 0.046 in diameter. Prepharynx very short (0.003), pharynx strongly muscular, oval, measuring 0.027 - 0.038 x 0.023 - 0.032. Oesophagus 0.032 - 0.072 long. Intestinal caeca reaching to holdfast organ. Holdfast organ large, measuring 0.063 - 0.097 x 0.053 - 0.090; its opening up to 0.015 long. Side of metacercarial body filled in with numerous elongated, transversaly situated body. Excretory canals filled with dark, dense granules situated between intestinal caeca and out of them.

Host and localities: *Esomus longimana* (1) - 1d; *Rasbora borapetensis* (1) - 1d; Cyprinidae gen. sp. juv. (3) - 1l; *Trichopsis vittata* (1) - 1c.

Localization: muscles.

Comments: metacercariae are morphologically identical with larvae of genera *Prohemistomium* Odhner, 1913 and *Paracoenogonimus* Katsurada, 1914 of the family Prohemistomatidae Sudarikov, 1961. The genus *Prohemistomum* differs from *Paracoenogonimus* species by somewhat smaller holdfast organ and absence of caudal process. *Prohemistomum* metacercariae have been found in silurid, cyprinid and perciform fish in North America, Africa, USSR and Asia (Fahmy and Selim 1959, Rai and Pande 1969, Yamaguti 1971 Bykhovskaya-Pavlovskaya and Kulakova 1987). Metacercariae of *Paracoenogonimus* species parasitize cyprinid fish in Europe and USSR including Amur basin (Yamaguti 1971, Bykhovskaya-Pavlovskaya and Kulakova 1987).

Family Opisthorchiidae Braun, 1901

8. *Opisthorchis viverrini* (Poirier, 1886)

Description: metacercaria is described and figured in a separate paper by Scholz et al. (1991).

Hosts and localities: *Barbodes gonionotus* (1) - 3; *Cyclocheilichthys repasson* (17) - 11, 3; *Hampala dispar* (16) - 3; *H. macrolepidota* (3) - 3; *Puntius brevis* (3) - 1i, 11; *Puntius* sp. (3) - 1c, 11;

Localization: muscles

Comments: see papers by Ditrich et al. (1990) and Scholz et al. (1991).

Family Heterophyidae Odhner, 1914

9. *Centrocestus formosanus* (Nishigori, 1924) Fig. 4 A - D

Description: cyst oval, thick-walled, measuring 0.18 - 0.24 x 0.14 - 0.20. Thickness of outer cyst wall 0.009 - 0.019; inner wall very thin, transparent, visible only after releasing of metacercariae from cyst. Metacercariae mostly folded in cyst, C-shaped, measuring 0.46 - 0.49 x 0.12 - 0.15. Maximum body width at level of ventral sucker, forward body narrowing. Body surface densely covered with short spines, about 0.002 long, backward smaller and less densely arranged. Oral sucker oval or nearly rounded, 0.041 - 0.057 x 0.046 - 0.049 in diameter. Circumoral spines present, arranged in two alternating rows of 32 triangular spines. Upper row consists of 16 larger spines measuring 0.012 - 0.013 x 0.003 - 0.004 (thickness about 0.002), lower row of 16 smaller spines, 0.010 - 0.011 x 0.003 in size (thickness less than 0.002) (Fig. 4 D). Rounded ventral sucker, 0.036 - 0.045 x 0.039 - 0.043 in size, situated in posterior body half. Prepharynx relatively long (0.055 - 0.057), longer than oesophagus (0.032 - 0.039). Pharynx measuring 0.026 - 0.034 x 0.027 - 0.034. Intestine containing numerous discoidal bodies, intestinal caeca short, not reaching to level of anterior margin of excretory bladder. Small, weakly visible anlage of ovary localized in front of X - shaped excretory bladder, anlagen of two testes situated laterally to it.

Host and localities: *Esomus longimana* (10) - 1c, 1d.

Localization: gills.

Comments: only *C. cuspidatus* (Looss, 1896), *C. armatus* (Tanabe, 1922) and *C. formosanus* (Nishigori, 1924) are considered to be valid of the *Centrocestus* species hitherto described (Chen 1942, Premvati and Pande 1974). Their differential diagnosis has been based mainly on number of circumoral spines: 36 in *C. cuspidatus*, 40 - 44 in *C. armatus* and 30 - 36 (usually 32 - 34) in *C. formosanus* according to the above authors. Specimens from *E. longimana* fully correspond in spine number with the last species. Moreover, other important morphological features such as length of prepharynx and shape of excretory bladder are also identical with these characters of *C. formosanus* - Chen (1942), Pande and Shukla (1972), Premvati and Pande (1974) and Yamaguti (1975).

The species *C. formosanus* is a widespread parasite of fish-eating birds and mammals including man. Metacercariae encysted in fish, mainly in cyprinid ones, have been found in China, Taiwan, Japan, Philippines and India (Premvati and Pande 1974, Yanohara 1985). Pande and Shukla (1972) found *C. formosanus* metacercariae in *Esomus danricus* in India. *Esomus longimana*, in which metacercariae from Laos were found, represents a new fish host of *C. formosanus*. Metacercariae of the genus *Centrocestus* can cause serious disease or even death of highly infected fish (Paperna 1964, Yermolenko and Besprozvannykh 1987).

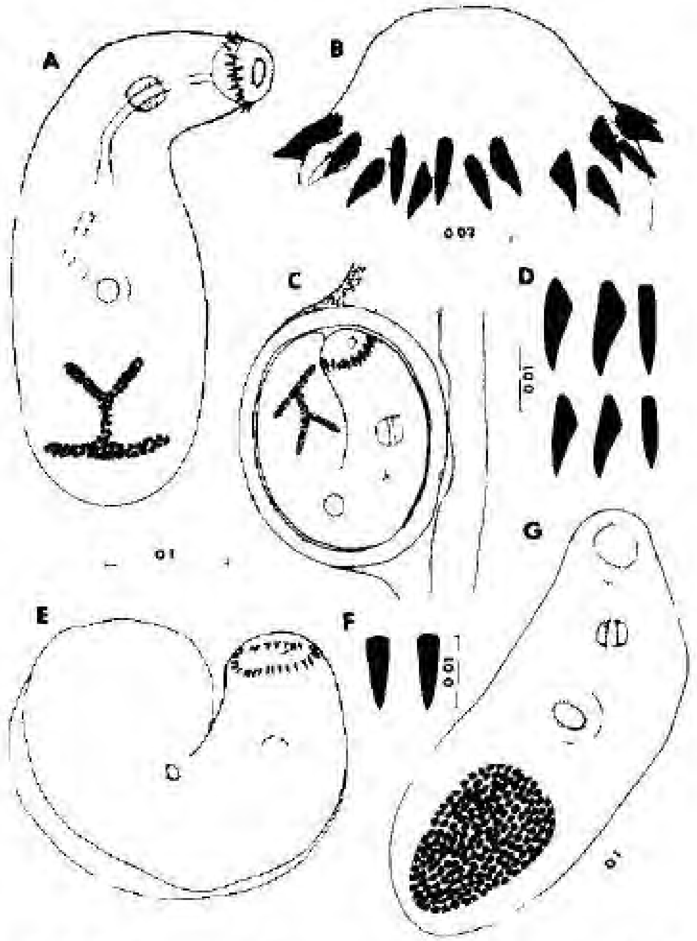

Fig. 4 A, B, C, D - *Centrocestus formosanus* (Nishigori, 1924) (after Scholz et al. 1991), E, F - Cryptogonimidae gen. sp., G - metacercaria type 1. A, G - excysted metacercaria, C, E - encysted metacercaria, B - oral sucker; D, F - circumoral spines.

10. *Haplorchis pumilio* (Looss, 1896) Fig. 5 F

Description and comments: see Scholz et al. (1991).

Hosts and localitites: *Esomus longimana* (1) - 1i, *Hampala macrolepidota* (1) - 3

Localization: muscles.

11. *Haplorchis taichui* (Nishigori, 1924) Fig. 5 A, C, D

Description and comments: see Scholz et al. (1991).

Host and localities: *Barbodes gonionotus* (4) - 2a, 3, *Hampala dispar* (4) - 2a, 3, *H. macrolepidota* (2) - 3, *Mystacoleucus marginatus* (8) - 2a.

Localization: muscles

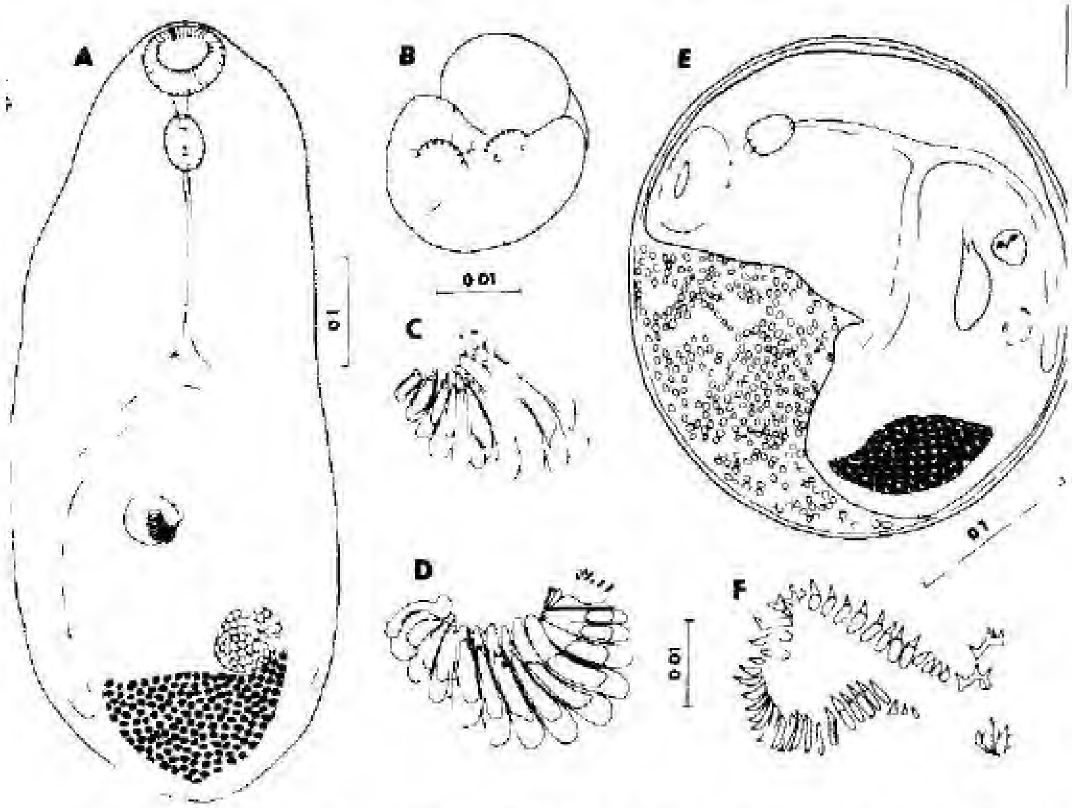

Fig. 5 A, C, D - *Haplorchis taichui* (Nishigori, 1924), B, E - *Stellantchasmus falcatus* Onji et Nishio, 1916, F - *H. pumilio* (Looss, 1896). A - excysted metacercaria, B - ventrogenital sac, C, D, F - sclerites of ventrogenital sac, E - encysted metacercaria (After Scholz et al. 1991, modified)

12. *Stellantchasmus falcatus* Onji et Nishio, 1916 — Fig. 5 B, E

Description and comments: see Scholz et al. (1991).

Host and locality: *Xenentodon cancila* (1) - 3.

Localization: fins

13. *Haplorchoides mehrai* Pande et Shukla, 1976 — Fig. 6

Description: cysts oval or nearly rounded, double-walled, measuring 0.15 - 0.30 x 0.14 - 0.27. Thickness of cyst walls 0.005 - 0.041. Metacercariae in cyst C- or S-shaped, sometimes not folded, their size 0.29 - 0.77 x 0.10 - 0.25. Body surface covered with numerous scale-like spines, posteriorly smaller and less densely arranged. Oral sucker oval, measuring 0.026 - 0.062 x 0.034 - 0.075. Ventrogenital sac containing oval ventral sucker measuring 0.017 - 0.046 x 0.017 - 0.044. Sucker divided into two parts and armed with three groups of serrated (pectinated) sclerites. Anteromedial and posterior groups measuring 0.007 - 0.008 x 0.007 - 0.010 consist of 8 - 9 sclerites 0.003 - 0.008 long. Anterolateral group, 0.003 - 0.005 wide, consists of four sclerites 0.004 - 0.006 long

Sclerites bolt-shaped in transverse view. Prepharynx very long (0.05 - 0.23), considerably longer than oesophagus (length 0.016 - 0.077). Pharynx oval, 0.027 - 0.053 x 0.019 - 0.050 in size. Intestinal caeca reaching to anterior margin of excretory bladder. Ovary anlage weakly developed, measuring 0.0015 - 0.020 x 0.025 - 0.035; testis anlage measuring 0.027 - 0.114 x 0.024 - 0.103 situated in front of large excretory bladder. Anlage of seminal vesicle preovarial, weakly visible. Excretory bladder measuring 0.041 - 0.103 x 0.057 - 0.141. Flame cells slightly visible, in groups of two cells; their total number estimated to be 10 or more in each body side.

H o s t s a n d l o c a l i t i e s : *Barbodes* cf. *foxi* (1); *B.gonionotus* (31); *B. schwannenfeldu* (23); *Hampala dispar* (49); *H. macrolepidota* (21); *Puntius brevis* (1); *Puntius* sp. (2); *Puntioplites proctozysron* (4); *Mystacoleucus marginatus* (7); *Cyclocheilichthys repasson* (7) - all locality 3; *Cyclocheilichthys* sp. (1) - 2b, *Sikukia gudgeri* (1) - 2b.

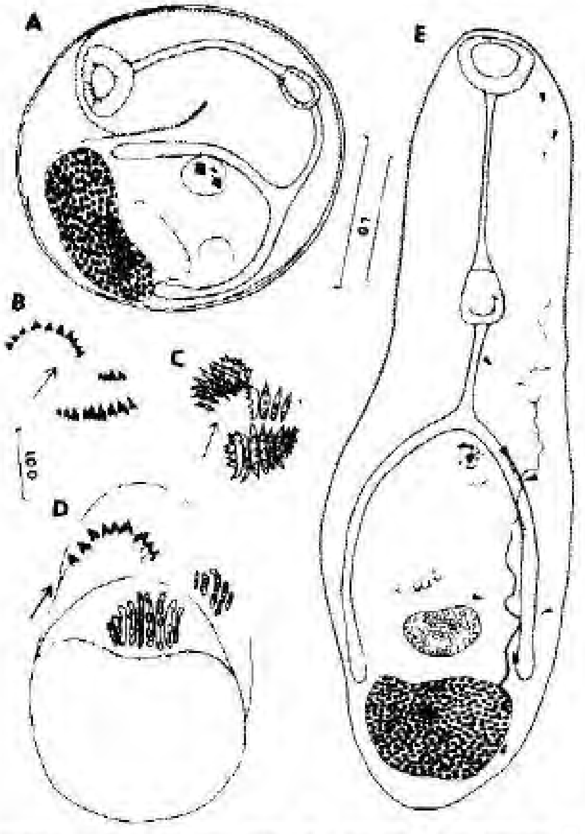

Fig. 6. *Haplorchoides mehrai* Pande et Shukla, 1976; A - encysted metacercaria; B, C - sclerites of ventrogenital sac; D - ventrogenital sac; E - excysted metacercaria. (Arrows indicate the median line of the body)

L o c a l i z a t i o n : muscles, exceptionally fins.

C o m m e n t s : until now, 23 species of the genus *Haplorchoides* Chen, 1949 have been described. However, only four of them are considered to be valid: type species *H.*

cahirinus (Looss, 1896), *H. attenuatus* (Srivastava, 1935), *H. pearsoni* Pande et Shukla, 1976 and *H. mehrai* Pande et Shukla, 1976 - R a i and P a n d e (1968), P a n d e and S h u k l a (1976), S h a m e e m and M a d h a v i (1988).
The most important diagnostic feature for identification of *Haplorchoides* species is the armature (spination) of ventrogenital sac. By this feature, metacercariae from Laos well correspond with the species *H. mehrai*. The correctness of specific identification was also confirmed by Prof. J. C. Pearson (pers. comm.).
H. mehrai adults has hitherto been only recorded in silurid fish from India (P a n d e and S h u k l a 1976, S h a m e e m and M a d h a v i, 1988). However, among slides of *Haplorchoides* species that we had examined, deposited in the Natural History Museum in London, several adult specimens of *H. mehrai* from the river Chaopraya in Thailand and designated as *Haplorchoides* sp. were found. In addition, one adult of *H. mehrai* has been recorded in *Mystus rhegma* from Laos (see S c h o l z 1991).

14. Metacercaria type 1 Fig. 4 G

D e s c r i p t i o n (after two living specimens): thick-walled cyst oval, 0.37 x 0.29 in diameter, containing metacercaria measuring 0.51 - 0.58 x 0.22 - 0.24. Oral sucker oval, 0.061 - 0.101 x 0.084 - 0.090 in diameter. Widely oval ventral sucker situated at the end of anterior body part, measuring 0.046 - 0.077 x 0.065 - 0.088. Prepharynx 0.05 long, considerably longer than oesophagus (0.03). Pharynx 0.027 - 0.034 x 0.027 - 0.044 in size. Intestinal caeca long, reaching along excretory bladder nearly to posterior end of body. Excretory bladder sac-shaped, anteriorly reaching very far between intestinal caeca, containing a great number of oval excretory granules.
H o s t a n d l o c a l i t y : *Trichopsis* sp. (1) - Ii.
L o c a l i z a t i o n : muscles

C o m m e n t s : by some morphological features, specimens from Laos closely resemble „metacercaria type 3" found by M o r a v e c (1977) in *Tilapia zilli* from Egypt. Moreover, hosts of both types of metacercariae are perciform fish.

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REFERENCES

B y k h o v s k a y a - P a v l o v s k a y a , I. E., K u l a k o v a A. P., 1987: [Class Trematodes - Trematoda Rudolphi, 1808.] In: B a u e r , O. N. (Ed.): Key to the parasites of freshwater fish. Vol. 3. Publ. House Nauka, Leningrad, pp. 77 - 198. (In Russian.)

Chen, H. T., 1942: The metacercaria and adult of Centrocestus formosanus (Nishigori, 1924), with notes on the natural infection of rats and cats with C. armatus (Tanabe, 1922). *J. Parasitol.*, 28: 285 - 298.

Chen Chin-leu (editor) 1964: [An illustrated guide to the fish diseases and causative pathogenic fauna and flora in the Hubei Province.] Academia Sinica Press, Peking, 456 pp. (In Chinese.)

Chiang, C. P., 1951: A comparative study of two species of Encyclometra metacercariae and their development in experimental hosts (Trematoda: Plagiorchiidae). *Lingnan Sci. J.*, 23: 201 - 215.

Ditrich, O., Scholz, T., Giboda, M., 1990: Occurrence of medically important small flukes (Trematoda: Opisthorchiidae, Heterophyidae) in the Nam Ngum water reservoir, Laos. *Southeast Asian J. Trop. Med. Pub. Hlth.*, 21: 482 - 488.

Dollfus, R. P., 1963: Trematodes Digenea adultes chez des Batraciens, Reptiles, Oiseaux. *Annal. Parasitol. Hum. Comp.*, 38: 29 - 61.

Dubois, G., 1964: Du statut de quelques Strigeata La Rue, 1926 (Trematoda). *Bull. Soc. Neuchâtel. Sci. Nat.*, 87: 27 - 71.

Fahmy, M. A. M., Selim, M. K., 1959: Studies on some trematode parasites of dogs in Egypt with special reference to the role played by fish in their transmission. *Z. Parasitenkd.*, 19: 3 - 13.

Gaevskaya, A. V., Aleshkina, L. D., 1985: Novye vidy trematod ryb vostochnoi Atlantiki [New species of fish trematodes in East Atlantic.] *Parazitologiya*, 19: 105 - 112: (In Russian.)

Gupta, N. K., Mehrotra, V., 1977: Redescription of Encyclometra columbrimurorum (Rudolphi, 1819) with remarks on the synonymy of E. vitellata Gupta, 1964. *Folia Parasitol.*, 24: 179 - 182.

Joyeux, C., Houdemer, E., 1928: Recherches sur la faune helminthologique de l'Indochine (Cestodes et Trematodes). *Annal. Parasitol. Hum. Comp.*, 6: 27 - 58.

Kottelat, M., 1989: Zoogeography of the fishes from Indochinese inland waters with an annotated check-list. *Bull. zool. Mus. Univ. Amsterdam*, 12 (1), 1 - 54.

Moravec, F., 1977: Some digenetic trematodes from Egyptian freshwater fishes. *Věst. čs. Společ. zool.*, 41: 52 - 67.

Moravec, F., Sey, O., 1989: Some trematodes of freshwater fishes from North Vietnam with a list of recorded endohelminths by fish hosts. *Folia Parasitol.*, 36: 243 - 262.

Pande, B. P., Shukla, R. P., 1972: Metacercarial cyst of Haplorchis pumilio, its development in experimental mammals and two other heterophyid infections of fresh-water fishes and their zoonotic significance. *Indian J. Anim. Sci.*, 42: 971 - 978.

Pande, B. P., Shukla, R. P., 1976: Haplorchoides Chen, 1949 (Haplorchinae: Heterophyidae) in freshwater fishes. *J. Helminthol.*, 50: 181 - 192.

Paperna, I., 1964: The metazoan parasite fauna of Israel inland water fishes. Bamidgeh, 16: 3 - 66.

Premvati, G., Pande, V., 1974: On Centrocestus formosanus (Nishigori, 1924) Price, 1932 and its experimental infection in White Leghorn Chicks. *Japan. J. Parasitol.*, 23: 79 - 84.

Rai, P., Pande, B. P., 1967: Observations on the haplorchine flukes hitherto known from Indian siluroid fishes. *Agra Univ. J. Res.*, 16: 17 - 24.

Rai, P., Pande, B. P., 1969: On the morphology and pathogenic significance of the strigeoid metacercariae in some Indian fresh-water fishes II. Prohemistomulum. *Indian J. Anim. Sci.*, 39: 360 - 364.

Scholz, T., 1991: Observations on trematode fauna of freshwater fish in Laos. *Helminthologia*, 28: 125 - 130.

Scholz, T., Ditrich, O., Giboda, M., 1991: Larval stages of medically important flukes (Trematoda) from Vientiane province, Laos. Part I. Metacercariae. *Annal. Parasitol. Hum. Comp.*, 65 (1990, published in 1991): 238 - 243.

Shameem, U., Madhavi, R., 1988: The morphology, life-history and systematic position of Haplorchoides mehrai Pande & Shukla, 1976 (Trematoda: Heterophyidae). *Syst. Parasitol.*, 11: 73 - 83.

S m i t h , H. M., 1945: The fresh-water fishes of Siam, or Thailand. Smithsonian Institution, USNM, Washington, 622 pp.

T a k i , Y., 1974: Fishes of the Lao Mekong basin. U.S.A.I.D. Mission to Laos, Agric. Division, Vientiane, 232 pp.

T a n g , C., T a n g , Z., 1976: [Studies on nine species of gasterostomes from Fujian, with observations on the life cycles of two species.] *Acta Zool. Sinica*, 22: 263 - 278. (In Chinese, English summary.)

W a n g , P., 1985: [Notes on some species of gasterostome trematodes of fishes mainly from Fujian province.] *J. Fujian Teachers Univ. (Nat. Sci.)*, No. 4: 73 - 83. (In Chinese, English summary.)

Y a m a g u t i , S., 1958: Systema Helminthum Vol. 1. The digenetic trematodes of invertebrates. Interscience, New York. 1575 pp.

Y a m a g u t i , S., 1971: Synopsis of digenetic trematodes of vertebrates. Vol. I, II. Keigaku Publishing Co., Tokyo. 1074 pp. + 349 Plts.

Y a m a g u t i , S., 1975: A synoptical review of life histories of digenetic trematodes of vertebrates. Keigaku Publishing Co., Tokyo, 590 pp. + 219 Plts.

Y a n g , F., 1959: [Studies on strigeid trematodes from birds. I. On a new genus and three new species in Diplostomatidae.] *Acta Zool. Sinica*, 11: 482 - 498. (In Chinese, English summary).

Y a n o h a r a , Y., 1985: On analysis of transmission dynamics of trematode infection 1. Centrocestus , formosanus infection in Miyakojima. *Japan. J. Parasitol.*, 34: 55 - 70.

Y e h , L., 1958: A review of the trematode genus Encyclometra Baylis and Cannon, 1924. *J. Helminthol.* 32: 99 - 114.

Y e r m o l e n k o , A. V., B e s p r o z v a n n y k h , V. V., 1987: [On pathological influence of some metacercariae of trematodes to fish from the south of Far East.] *Parazitologiya*, 21: 159 - 162.

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TROPHIC DYNAMICS AND GROSS MORPHOLOGY OF THE ALIMENTARY TRACT IN NEOMACHEILUS RUPICOLA (OSTEICHTHYES, COBITIDAE) FROM HIGH ALTITUDE FLUVIAL SYSTEM OF CENTRAL HIMALAYAS

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Abstract. Trophic spectrum of fish diet and percentage consumption of the animal food, plant food, and sand and detritus (69.6/8.2/22.2) is indicative that *Neomacheilus rupicola* (McClelland) inhabiting high altitude tributaries if the Upper Ganges of Central Himalayas is an euryphagic carni-omnivorous bottom feeder. The alimentary tract is short and the stomach consist of a corpus and a pylorus portion. The feeding intensity attains two peaks in a year, first in May and second in December. The variation in feeding intensity appear to be correlated mainly with the condition of the gonads *vis-a-vis* availability of food items in nature. A pronounced quantitative variation in the feeding intensity of two sexes has been observed, however, qualitative variation is not well marked. It is observed that the females feed moor voraciously than males.

INTRODUCTION

Neomacheilus rupicola (McClelland) occurring in high altitude shallow tributaries of the Upper Ganges of Central Himalayas (India), which is locally known as „Gadiyal", is an important palatable fish of the poor people. The present contribution deals with the gross morphology of its alimentary tract and seasonal variations in food and feeding intensity.

While considerable work has been done on the seasonal variation in food and feeding habits of freshwater teleost fishes by Kapoor (1953), Pillay (1953), Moitra (1956), Das and Moitra (1958), Khanna and Pant (1964), Agarwal and Tyagi (1969), Reiffell and Travill (1978) and Rita Kumari and Nair (1979), etc. However, very little information is available on this aspect of high altitude stream fishes except that of Jyoti and Malhora (1975), Somvanshi and Bapat (1979), Sharma (1983), Singh and Bahuguna (1983), Sharma (1984a, 1987a, 1987b).

MATERIAL AND METHODS

The fish *(Noemacheilus rupicola)*, locally known as „Gadiyal", collected weekly from the tributaries of the upper Ganges of Central Himalayas, were brought to the laboratory. The Total length and weight of the fishes were determined. The stomach of each fish was removed and the condition of the gonad was noted. The weight of the food was noted by calculating the difference in the weight of the stomach with and without contents. The gastro-somatic indices (GSI) were calculated as follows -

$$GSI = \frac{\text{Weight of stomach contents}}{\text{Weight of fish}} \times 100$$

For the qualitative studies of food, the stomach contents were preserved in 5% formalin for subsequent studies. The preserved food contents were mounted on slides in Reyne's mountant (Chloral hydrate 50 g, water 58 ml, glycerine 12.5 ml and gum arabica 30 g). Then each food item was observed under the stereoscopic microscope. In order to find out the volumetric contribution of each food item, volume displacement technique to measure items > 0.05 cm^3 and a squash technique to measure volume of food items < 0.05 cm^3 were followed (S h a r m a 1987b). The various food items were identified up to lowest possible taxon.

The relative length of the gut (RLG) was calculated by dividing the length of the gut by the total length of the fish. For the study of alimentary tract, the abdomen of the fish was opened and the alimentary tract from the oesophagus to rectum carefully removed, fixed and studied.

RESULTS

Gross morphology of the alimentary tract

The alimentary tract of *Noemacheilus rupicola* is shorter than its body length. The oesophagus which opens into the stomach is narrow and short. The stomach consists of a large corpus and a small pylorus. The proximal part of the intestine, into which the bile duct opens, is looped. The rest of the part (distal) of the intestine is almost straight (Fig. 1).

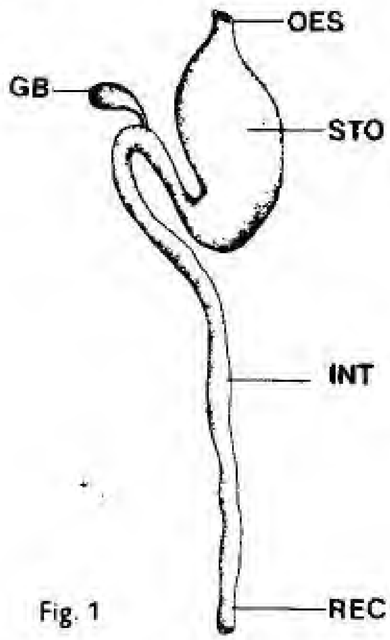

Fig. 1

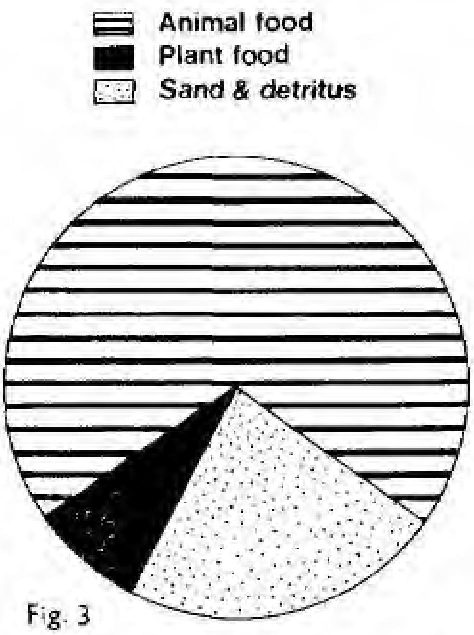

Fig. 3

Fig. 1. Alimentary tract of *N. rupicola*: OES - oesophagus, STO - stomach, GB - gall-blader, INT - intestine, REC - rectum.

Fig. 3. Average annual diet composition of *N. rupicola*.

Table 1. Monthly variation in the volumetric contribution of major food items in the gut content of *Noemacheilus rupicola* (McClelland)

Months	Green matter %	Diatoms %	Insects and their larvae %	Crustaceans and their larvae %	Protozoans and rotifers %	Other food*) %	Sand and detritus %
Jan.	10.5	4.5	40.5	20.5	12.5	3.0	8.5
Feb.	9.5	3.0	44.5	22.0	7.5	3.5	10.0
Mar.	7.0	-	52.0	24.0	8.5	-	8.5
Apr.	4.0	-	51.5	23.5	6.5	1.0	13.5
May	5.5	2.5	34.5	26.0	6.0	4.5	21.0
Jun.	7.5	1.0	28.5	28.5	4.0	1.5	29.0
Jul.	2.5	-	19.0	36.5	-	4.0	38.0
Aug.	3.0	-	20.5	34.0	-	1.5	41.0
Sep.	6.0	-	27.0	29.0	3.5	2.5	32.0
Oct.	7.0	0.5	32.0	25.5	7.0	1.0	27.0
Nov.	9.0	1.5	36.5	22.0	8.0	1.5	21.5
Dec.	11.0	2.5	41.0	18.5	11.0	-	16.0
Mean ($\bar{x}$)	6.9	1.3	35.6	25.8	6.2	2.0	22.2

*) Other food includes pieces of molluscan shells, fish parts, and nematodes

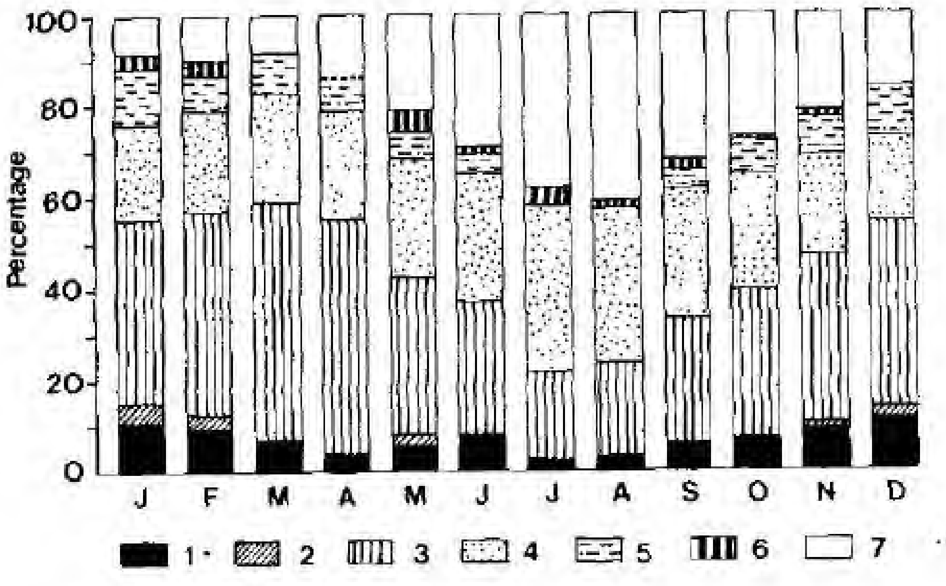

Fig. 2. Monthly percentage composition of different food items in *N. rupicola* for year 1980.

Trophic dynamics

A detailed seasonal qualitative analysis of gut contents of *N. rupicola* has revealed that the fish feeds on green matter (algae, etc.) diatoms, insects and their larvae, crustaceans and their larvae, protozoans and rotifers, and other food including pieces of molluscan shells, nematodes and fish parts. The insects and their larvae occupied top position ($\bar{x}$ = 35.6%) in the composition of stomach contents, whereas crustaceans and their larvae ($\bar{x}$ - 25.8) and green matter ($\bar{x}$ = 6.9%) rank next in order of their percentage occurrence (Fig. 2, Table 1). The percentage compositioin of animal food, plant food, and sand and detritus which were recorded to be $\bar{x}$ = 69.6%, $\bar{x}$ = 8.2% and $\bar{x}$ = 22.2% respectively (Fig. 3) showed that the fish was euryphagic carniomnivorous.

Qualitatively, much difference has not been observed in the food contents of male and female fishes. However, male and female fish do differ in the quantity of food they take during different months of the year.

Qualitative trophic dynamics

Qualitatively the diet of the *Noemacheilus rupicola* consists of the following food items (Table 1).

(a) Green matter: A look at Table 1, Fig. 2 reveals that the green matter was found in the stomach contents throughout the year and ranged from 2.5 to 11.0%. The maximum percentage of this green food has been recorded in December, while minimum (2.5 to 3.0%) during monsoon months (July - August). The green matter of the gut comprised of fragments and filaments of algae (*Hydrodictyon*, *Microspora*, *Spirogyra*, *Ulothrix*, *Schizogonium* and *Cladophora*).

(b) Diatoms: These constitute a feeble 1.3% of annual food intake by the fish. *Diatoma*, *Navicula*, *Pinnularia* and *Synedra* are the diatoms which were observed in the diet of the fish.

(c) Insects and their larvae: The nymphs, larvae and parts of the adult insects form the major bulk of the fish food and is a consistent food item reaches its peak (51.5%) in April while minimum (19.0%) in July (Table 1). The insect food comprised of the larvae and nymphs of *Dinutes*, *Helochares*, *Paracymus*, *Potamonectes*, *Sternolophus*, *Eristalis*, *Baetis*, *Gerris*, *Heleocoris*, *Micronecta*, *Sympetrum*, *Isoperla*, *Perla* and *Hydropsyche*.

(d) Crustaceans and their larvae: The second important food item of the fish consisted of crustaceans and their larvae, which were met within fairly marked quantities in the gut contents. The important crustaceans and their larvae identified during the course of qualitative analyses were *Cyclops*, *Cypris*, *Daphnia*, and *Diaptomus*.

(e) Protozoans and rotifers: These food items were present round the year except in monsoon months (July - August) in the gut contents of the fish. The

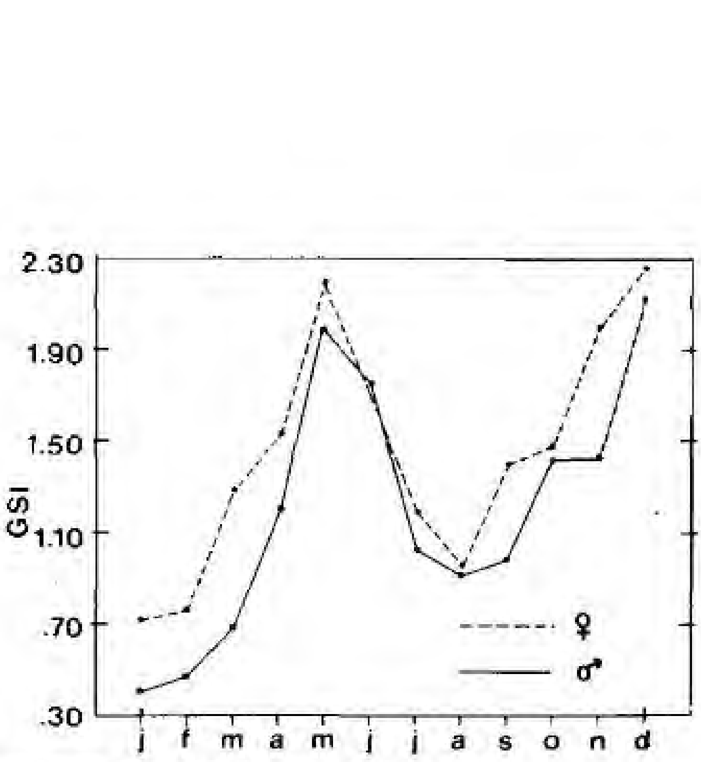

Fig. 4. Seasonal variations in GSI of both the sexes of *N. rupicola*.

maximum percentage of protozoans and rotifers were recorded in the month of January (12.5%). The protozoans, *Volvox*, and *Zoothamnum* and the rotifers, *Brachionus*, *Philodina* and *Mytilina* contributed as fish food.

(f) O t h e r f o o d : Besides the above food items, pieces of molluscan shells, fish parts and nematodes were also observed in the gut contents contributing only 2.0% of the annual food (Fig. 3). The important nematodes were *Aphelenchoides*, *Microlaimus* and *Chronogaster*.

(g) S a n d a n d d e t r i t u s : Sand and detritus were met within the stomach contents almost all the year round and range from a minimum of 8.5% to a maximum of 41.0% (Table 1).

Quantitative trophic dynamics

The study of gastrosomatic index (GSI) of *N. rupicola* reveals that in both male and female fishes (Tabel 2, Fig. 4), the feeding intensity attains two peaks during the course of a year. The first peak was observed in May and then the second in December. Correspondingly two falls have also been recorded, once during January and the again in July - August.

Relative length of the gut

The relative length of the gut (RLG) varied from 0.628 ± 0.0078 to 0.871 ± 0.0154 depending on the size of the fish (Table 2).

Table 2. Monthly variations in the values of GSI nad RLG in *N. rupicola* (McClelland)

Month	Males		Females		Males and Females	
	No. of fishes examined	GSI mean ± SD	No. of fishes examined	GSI mean ± SD	NO. of fishes examined	RLG mean ± SD
Jan.	18	0.413 ± 0.0057	19	0.726 ±.0113	21	0.871 ± 0.0154
Feb.	21	0.474 ± 0.0068	23	0.863 ±.0154	26	0.728 ± 0.0103
Mar.	19	0.681 ± 0.0123	21	1.281 ±.0245	19	0.686 ± 0.0098
Apr.	26	1.205 ± 0.0277	28	1.520 ±.0425	20	0.710 ± 0.0146
May	27	1.986 ± 0.0124	22	2.187 ±.0905	24	0.804 ± 0.0168
Jun.	17	1.743 ± 0.0468	21	1.726 ±.0489	26	0.814 ± 0.0143
Jul.	18	1.038 ± 0.0261	20	1.223 ±.0246	19	0.802 ± 0.0139
Aug.	20	0.909 ± 0.0105	16	0.975 ±.0276	18	0.725 ± 0.0095
Sep.	24	0.986 ± 0.0121	27	1.412 ±.0310	21	0.628 ± 0.0078
Oct.	28	1.431 ± 0.0352	22	1.484 ±.0396	23	0.706 ± 0.0086
Nov.	19	1.436 ± 0.0346	18	2.008 ±.0761	24	0.715 ± 0.0089
Dec.	22	2.128 ± 0.0926	23	2.268 ±.1055	20	0.794 ± 0.0107

DISCUSSION

Nikolsky (1963) classified the food of a fish into basic food, secondary food, incidental food and obligatory food. The basic food of *N. rupicola* was observed as green matter (algae), insects and their larvae, and crustaceans and their larvae, which formed the major bulk of the gut contents. Diatoms, protozoans and rotifers contributed as secondary food. Besides the above food items, parts of fish body and pieces of molluscan shells were observed incidentally in the gut contents. On the basis of diet composition of the fish it may be inferred that *N. rupicola* is a euryphagic (having wide range of diversity in fish diet) omnivorous. As it consumes more animal food (69.6%) than the plant food (8.2%), it may be better called a euryphagic carni-omnivore, which is in conformity with the view of Singh and Bahuguna (1983) on an allied species, *N. montanus* (McClelland). According to Khanna and Pant (1964) *N. rupicola* is an insectivore, feeding exclusively on insects and crustaceans. Such an inference is perhaps based on the fact that the insects and crustaceans dominate (69.6%) in the trophic composition of the fish. Jyoti and Malhotra (1975) have opined that *N. kashmirensis* Hora is a herbi-omnivore. Ritakumari and Nair (1979) have reported that *N. triangularis* Day is an insectivorous. Intraspecific variations in the food constituents under varying ecological conditions are already known (Moitra, 1956), in view of which the differences in the feeding of *N. rupicola* (McClelland), *N. montanus* (McClelland), *N. kashmirensis* Hora and *N. triangularis* Day seem to be understandable.

Das and Pathani (1978) have pointed out that the position of bile duct is an important criterion in deciding whether the fish has „intestinall bulb" or stomach and also the food of the fish. They observed that in *T. putitora* (omnivore), the opening of the bile duct is at 1/3 length posteriorly from the junction of oesophagus and

„intestinal bulb". But with more and more carnivorous diet the bile duct opening is shifted towards the end of the sac (stomach). The present observation on *N. rupicola* also supports the view of D a s and P a t h a n i (1978). The presence of sand and detritus in appreciable quantities is an indication that *N. rupicola* is a bottom feeder.

The feeding intensity attained two peaks during a year, first in the month of May and second in December (Fig. 4). This change in feeding intensity appears to be correlated with the condition of the gonads vis a vis availability of food items in nature. The first peak in the month of May, when fish feeds voraciously, may be due to the fact that the fish gonads are under the process of growth and maturation during this period. This inference confirms the views of M a l h o t r a (1967) reported in case of an allied form *Botia birdi* Chaudhary. The second peak in the month of December and the down trend in feeding intensity in the monsoon months (July - August) may be well correlated with the availability of an ample amount of fish food in the month of December and the severe scarcity of food during monsoon months in the high altitude tributaries of the Upper Ganges of Central Himalayas (S h a r m a 1984b). However, an interesting fact emerges from the comparision of GSI of two sexes (Table 2, Fig. 4) that the females are relatively more voracious feeders than the males.

The RLG values of *N. rupicola* varied from 0.628 ± 0.0078 to 0.871 ± 0.0154. As the fish is a carni-omnivorous, the length of its gut is shorter than its body length. This observation supports the view of V e r i g h i n a and M e d a n i (1968). The monthly variation in the RLG of the fish (Table 2) can also be correlated with the conditions of food supply, amount of indigestible matter, season and age (K a p o o r, S m i t and V e r i g h i n a 1975).

SUMMARY

N. rupicola (McClelland) feeds on a wide varieties of food, which shows that the fish is a versatile feeder utilizing favoured food when they are available and changes to other when occasion demands. However, relatively favours to feed on nymphal or larval stages of insects, crustaceans and their larvae, protozoans and rotifers and algal green matter available in the high altitude fluvial system of Central Himalayas.

The fish feeds voraciously during postspawning period to regain the weight lost during spawning. This feeding activity is enhanced when food is available in ample amount in fish habitats. The fishes ceases to feed or abstain from active feeding during the period of spawning. Considerable sexual variation in the feeding intensity of two sexes of the species has been observed, as the female fish feeds more voraciously than males.

The alimentary tract is short and the stomach consists of a corpus and pylorus portion, which indicates that the fish thrives more on carnivorous diet (69.6%).

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LITERATURE

Agarwal, V. P., A. P. Tyagi, 1969: Food, feeding habits and the alimentary canal of freshwat fishes of Muzaffarnagar. *Agra Univ. J. Res.*, 18: 15 - 22.

Das, S. M., S. K. Moitra, 1958: On the feeding types of fishes and the variation s in the alimentar canal in relation to food. *Journ. Ichth.*, 10: 29 - 40.

Das, S. M., S. S. Pathani, 1978: Studies on the biology of Kumaun Mahseer (*Tor putito* Hamilton): Adaptation of the alimentary tract in relation to feeding habits, body length and bod weight. *Indian J. Anim. Sci.*, 48: 461 - 465.

Jyoti, M. K., Y. R. Malhotra, 1975: Seasonal variation in feeding of Noemacheilus kashmirensi Hora. *Matsya*, 1: 53 - 58.

Kapoor, B. G. 1953: The anatomy and histology of the alimentary canal in relation to its feeding habit of a siluroid fish Wallago attu (Ill & Schn.). *J. Zool. Soc. India*, 5: 191 - 200.

Kapoor, B. G., I. A. Verighina, 1975. The alimentary canal and digestion in teleosts. *Adv. Mar Biol.*, 13: 109 - 239.

Khanna, S. S., M. C. Pant, 1964: On the digestive tract and the feeding habits of some teleostea fishes. *Agra Univ. J. Res.*, 13: 15 - 30.

Malhotra, Y. R. 1967: A preliminary account of the relationship between feeding and ovarian cycl in Schizothorax niger Heckel and Botia birdi Chaudhary. *Indian J. Fish.*, 14: 313 - 317.

Moitra, S. K. 1956: On the food habits of certain fishes in Lucknow. *Proc. Zool. Soc. Bengal.*, 9: 89 - 91.

Nikolsky, G. V. 1963: The Ecology of Fishes. Acad. Press. London., 853, pp.

Pillay, T. V. R. 1953: Studies on the food, feeding habits and alimentary tract of the gray mullet (Mugi tade). *Proc Nat. Inst. Sci. Calcutta (India).*, 19: 777 - 827.

Reifel, C. W., A. A. Travill, 1978. Gross morphology of the alimentary canal in 10 teleostean species. *Anat. Anz. Jena*, 144: 441 - 449.

Rita Kumari, S. D., N. B. Nair, 1979: Food and feeding habits and rate of gastric digestion in Noemacheilus triangularis Day. *Proc. Indian natn. Sci. Acad.*, 45: 56 - 70.

Sharma, R. C. 1983. Seasonal variations in feeding of Glyptothorax pectinopterus (McClelland) of the Bhagirathi. *Uttar Pradesh J. Zool.*, 3: 19 - 24.

Sharma, R. C. 1984a: Trophic dynamics of snow-trout. Schizothorax richardsonii (Gray) of Garhwal Himalaya. *Indian J. Anim. Sci.*, 54: 666 - 669.

Sharma, R. C. 1984b: Potamological studies on lotic environment of the upland river Bhagirathi of Garhwall Himalaya. *Environment Ecol.*, 2: 239 - 242.

Sharma, R. C. 1987a: Trophic dynamics of the mahseer, Tor putitora (Teleostei, Cyprinidae), in the Central Himalayas. *Proc. V. Congr. europ. Ichthyol., Stockholm 1985*: 145 - 152.

Sharma, R. C. 1987b: Qualitative and quantitative trophic dynamics in a hill stream fish, Barilius bendelisis from upland fluvial system of the Ganges of Central Himalayas. *Věst. čs. Společ. Zool.*, 51: 228 - 239.

Singh, H. R., S. N. Bahuguna, 1983. Gross morphology of the alimentary canal and seasonal variation in feeding of Noemacheilus montanus (McClelland). *Anat. Anz. Jena*, 154: 119 - 124.

Somvanshi, V. S., S. S. Bapat, 1979: Food and feeding habits of a hillstream fish Garra mullya (Sykes). *J. Inland Fish. Soc. India*, 2: 87 - 93.

Verighina, I. A., J. U. I. Medani, 1968: Structure of the digestive tract in Distichodus rostratus depending upon the nature of feeding. *Voprosy Ikhtiologii*, 8: 710 - 721 (in Russian).

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A TRIBUTE TO JAROSLAV KRAMÁŘ (1910 - 1990)

On April 16, 1990 passed away at the age of 80 Jaroslav Kramář, an eminent Czechoslovak zoologist and parasitologist, professor at Charles University, Prague.

Jaroslav Kramář was born on April 11, 1910 in Velké Hamry (District Jablonec n. Nisou, Czechoslovakia). He obtained his education successively at the Pedagogical Institute in Jičín (1925 - 1929) and later as external student of biology and geography at the Faculty of Science, Charles University in Prague. His university studies were, however, interrupted during the 2nd World War when Czech universities were closed as result of German occupation. After the war he graduated in 1948 by submitting a thesis entitled „Vital Staining and Fluorescence of Larvae of Some Diptera".

The scientific career of Professor Kramář was marked by two landmarks: his deep involvement in teaching and his love of biology. He began to teach right after finishing the above mentioned Pedagogical Institute in 1929 and continued teaching at primary and secondary schools while enrolled at the University. His deep interest in biology, especially entomology (he became member of the Czechoslovak Entomological Society already in 1926 at the age of 16) and his pedagogical abilities became interwoven in 1951 when he became assistant of the late professor E. Bartoš (who himself was an eminent zoologist) at the Zoological Institute of the Pedagogical Faculty, Charles University.

A very decisive step in the professional life of Dr. Kramář presented the obtaining by him in 1951 of the position of senior assistant in the Department of Parasitology, Faculty of Science, Charles University, headed at that time by the founder of Czechoslovak parasitology, professor Otto Jírovec. Later, in 1954, Dr. Kramář was named assistant professor and in 1963 full professor at the same Department. Since 1953 up to 1978 he headed the Department of Parasitology and Hydrobiology.

The scientific work of professor Kramář was originally oriented to the study of parasitic Diptera, especially mosquitoes. His PhD thesis (1957) „Mosquitoes biting man and animals" published in the series „Fauna of Czechoslovakia" (Fauna ČSR) summarized his contribution to medical and veterinary dipterology.

Around 1960 professor Kramář turned his attention to the immunofluorescence which at that time was a novel method in parasitology. His work in this area was truly pioneering taking into account the material and technical difficulties involved in the introduction of the method into this country at that time. The experience of prof. Kramář with immunofluorescence was summarized in his thesis „The application of immunofluorescence in the diagnostics of toxoplasmosis" submitted in 1966 for the obtention of the „Doctor of Science" (DrSc) degree. Certaily the widespread use of immunofluorescence in the diagnostics of parasitic diseases in this country resulted from the initiative of prof. Kramář.

Professor Kramář published more than 50 scienfitic papers besides some publications oriented to the popularization of science. He was also the co-author of several textbooks of parasitology and zoology. Here, especially the Jírovec's „Medical, parasitology" (Parasitologie pro lékaře) and its German edition „Parasitologie für Ärtzte" should be mentioned as well as his continuing effort for the improvement of the quality of textbooks for high schools.

Professor Kramář inspired his knowledge and love for biology and parasitology in many of his students. He contributed to their professional careers as well by his work in the Advisory Board for Parasitology at the Ministry of Health where he insisted that parasitological laboratories in this country should be staffed by high quality professionals having biology and parasitology as background.

Profesor's Kramář students and friends will always remember him as a great personality combining love of biology and nature with hard work and modesty. His life which was so deeply devoted to teaching and research is the inspiration for his students and whole community of parasitologists in this country.

BIBLIOGRAPHY

All publications are arranged chronologically and divided into two groups: 1) original scientific papers and 2) books.

1) Original scientific papers

Kramář, J., 1949: Fluorescence a vitální barvení larev některých Dipter (Flourescence and vital staining of larvae of some Diptera). *Věst. Čs. spol. zool., 13: 239 - 266.*

Kramář, J., 1949: Contribution a l'etude de l'appareil digestiv de la larve de Corethra. *Věst. Čs. spol. zool.*, 13: 207 - 271.

Kramář, J., 1949: Nové druhy rodu Theobaldia pro ČSR (New species of the genus Theobaldia in Czechoslovakia). *Ent. listy*, 12: 43 - 45.

Kramář, J., 1949: Culex (Neoculex) apicalis v Československu (Culex (Neoculex) apicalis in Czechoslovakia). *Přírod. sborník ostr. kraje*, 10: 1 - 2.

Kramář, J., 1950: Parasiti larvy Tipula maxima (Parasites of larvae of Tipula maxima). *Věst. Čs. spol. zool.*, 14: 55 - 76.

Kramář, J., 1950: Mikroskopické peparáty členovců (Microscopical preparations of arthropods) *Přírodověda a výchova*, 3: 224 - 226.

Kramář, J., 1951: Příspěvek k poznání českých komárů (A contribution to the knowledge of mosquitoes from Bohemia). *Acta Societatis Entomol. Cechosl.* 48: 60 - 65.

K r a m á ř , J., 1951: Komáří kalamity na dolní Moravě (Calamities caused by mosquitoes in the region of Lower Moravia). *Ent. listy,* 14: 170 - 177.

K r a m á ř , J., 1951: Boj proti komárům (Control of mosquitoes). *Vesmír,* 225.

K r a m á ř , J., 1952: Anopheles plumbeus Steph. v ČSR (Anopheles plumbeus Steph. in Czechoslovakia). *Zool. a ent. listy,* 15: 90 - 94.

K r a m á ř , J., 1952: Hromadinka Lankesteria culicis Ross, parasit komára Aedes (Finlaya) geniculatus Oliv. (The gregarine Lankesteria culicis Ross, parasite of the mosquito Aedes (Finlaya) geniculatus Oliv.). *Věst. Čs. spol. zool.,* 16: 43 - 51.

K r a m á ř , J., J. W e i s e r ., B. R o s i c k ý , 1952: Příspěvek k poznání slovenských komárů (A contribution to the knowledge of mosquitoes from Slovakia). *Zool. a ent. listy,* 1: 198 - 203.

K r a m á ř , J., 1953: Příspěvek k mikroskopické preparaci členovců (A contribution to the technique of prepartion of arthropods). *Čsl. biologie,* 2: 57 - 58.

K r a m á ř , J., 1954: Příspěvek k poznání horských komárů (A contribution to the knowledge of mosquitoes from mountain regions). *Zool. a ent listy,* 3: 202 - 204.

K r a m á ř , J., 1954: Užití metakrylátů v mikroskopické technice (The use of methacrylates in microscopical technique). *Čsl. biologie,* 3: 117 - 118.

K r a m á ř , J., 1954: Líhniště komárů v nemocnici (Mosquito breeding sites in a hospital). *ČEMI,* 3: 303 - 305.

S l o n i m , D., J. K r a m á ř ., 1955: Pokus o průkaz přenosu virusu čs. klíšťové encefalitidy komáry našich krajů (I. část) (The attempt to transmit the virus of Czechoslovak tick encephalitis by our local mosquitoes (I part)). *ČEMI,* 4: 185 - 189.

K r a m á ř , J., D. S l o n i m , 1956: Pokus o průkaz virusu čs. klíšťové encefalitidy v komárech z jejího přírodního ohniska (II. část) (The attempt to demonstrate the presence of the virus causing tick encephalitis in Czechoslovakia in mosquitoes occurring in the natural nidus of the disease (II part)) *ČEMI,* 5: 185-189.

S l o n i m , D., J. K r a m á ř , 1956: Versuch der Übertragung des Virus der tschechoslowakischen Encephalitis durch einige Mückenarten. *Zbl. f. Bakt. I. Orig.,* 165: 61 - 68.

K r a m á ř , J., 1957: Culex territans v ČSR (Culex territans in Czechoslovakia). *Čs. parasitol.,* 4: 210 - 204

K r a m á ř , J., 1957: Výskyt Pyemotes (Pediculoides) ventricosus v ČSR (The occurrence of Pyemotes (Pediculoides) ventricosus in Czechoslovakia). *Čs. parasitol.,* 4: 205 - 207.

K r a m á ř , J., 1960: The inoculation of parasites Toxoplasma gondii into the eyes of albino rats. *Čs. parasitol.,* 7: 245 - 250.

K r a m á ř , J., 1961: Zdroj UV záření pro práce s konjugovanými fluorochromy (A UV light source for microscopy using conjugated fluorochromes). *Čs. morfol.,* 9: 329 - 332.

K r a m á ř , J., 1961: Theobaldia ochroptera in Czechoslovakia (Diptera, Culicidae). *Acta Soc. entomol. cechoslov.,* 58: 180 - 183.

K r a m á ř , J., 1964: Versuch der Verwendung markierter fluorescenden Antikörper in der serologischen Diagnose der Toxoplasma. Proceedings of the first International Conference on Protozoology, Prague, August 22. - 23., 1961, pp. 381 - 383.

K r a m á ř , J., 1963: Primenenie metoda fluorescirujiščich antitel v serologičeskoj diagnostike toxoplasmosa (The use of fluorescent antibodies in the serological diagnostics of toxoplasmosis) *Medic. parasitol.,* 4: 454 - 460.

K r a m á ř , J., 1963: Použití fluoreskujících protilátek v serologické diagnostice toxoplasmosy (The use of fluorescent antibodies in the serological diagnostics of toxoplasmosis). *Zprávy sekce mikrobiologů a epidemiologů,* 5: 41 - 47.

K r a m á ř , J., 1964: Použití fluoreskujících protilátek v serologické diagnostice toxoplasmosy (The use of fluorescent antibodies in the serological diagnostics of toxoplasmosis). Čs. parasitol., 11: 159 - 164.

K r a m á ř , J., Ž. Č e r n á , J. C h a l u p s k ý , 1964: Immunofluorescensreaktionen in der serologischen Diagnostik der Toxoplasmose. *Zbl. f. Bakt. I. Orig.,* 193: 523 - 534.

K r a m á ř , J., J. S t r e j č e k , V. R e j h o l e c , 1964: Průkaz LE faktoru imunofluorescenční

metodou (The identification of the LE factor using immunofluorescence assay). *Čas. lék. čes.*, 53 255 - 258.

Kramář, J., 1965: Použití suché krve na filtračním papíře v serologické diagnostice toxoplasmosy (The use of blood dried on filter paper in the serological diagnosis of toxoplasmosis). *ČEMI*, 14: 59 - 64.

Kramář, J., Ž. Černá, J. Chalupský, 1966: Důkaz toxoplasem v histologických řezech imunofluorescenční technikou (The detection of toxoplasma organisms in histological sections using immunofluorescence). *ČEMI*, 25: 321 - 327.

Kramář, J., O. Jírovec, 1966: The advantages of combining the indirect fluorescent antibody test and the intradermal test in the diagnosis of toxoplasmosis. *Folia parasitol.*, 13: 322 - 327.

Kramář, J., K. Kučera, 1966: Immunofluorescence demonstration of antibodies in urogenital trichomoniasis. *J. Hyg. Epid. Microbiol.*, 10: 85 - 88.

Kramář, J., Ž. Černá, J. Chalupský, M. Zástěra, J. Hübner, J. Pokorný, 1966: Relation of the indirect immunofluorescent reaction to the Sabin-Feldman reaction. *J. Hyg. Epid. Microbiol.*, 10: 355 - 360.

Kramář, J., J. Chalupský, J. Minář, 1967: Komáři Severočeského kraje (Mosquitoes of Northern Bohemia). *Sborník severočeského musea. Přírodní vědy. Liberec.*, 3: 167 - 174.

Jíra, J., J. Kramář, D. Zítová, J. Hübner, 1968: Titerverlaufskurven des Fluorescenz Tests und ihre Bedeutung für die Toxoplasmose-Diagnostik. *Ztschr. f. Immunitätsforschung, Allergie u. klinische Immunologie*, 135: 43 - 54.

Jírovec, O., J. Kramář, 1968: Relation entre le test intradermique et de la reaction indirecte d'immunofluorescence chez la toxoplasmose. *Information paper* 29: Reunion OMS de chercheurs sur la toxoplasmose. Genéve, 25. - 29. novembre, 1968, p. 1 - 2.

Kučera, K., J. Kramář, 1968: Die Komplementfärbung zum Nachweis komplementbindenen Antikörpers gegen Pneumocystis carinii. *Zbl. Bakt. I. Orig.*, 209: 106 - 111.

Kramář, J., J. Chalupský, 1970: Několik poznámek k použití nepřímé fluorescenční reakce v diagnostice toxoplasmosy (Remarks concerning the use fo the indirect fluorescent antibody test in the diagnostic of Toxoplasma). *ČEMI*, 19: 286- 290.

Kramář, J., J. Chalupský, J. Hübner, 1970: Relationship of the immunofluorescence reaction and the Sabin-Feldman reaction (Second report). *ČEMI*, 14: 129 - 134.

Jíra, J., D. Zítová, D. Princová, J. Hübner, J. Kramář, O. Jírovec, V. Bozděch, 1970: Lymphadenitis toxoplasmatica se zvláštním zřetelem k dlouhodobě sledovaným sérovým protilátkám (Toxoplasmic lymphadenitis with special regard to long-term occurring antibodies). *Vnitřní lékařství*, 16: 770 - 786.

Červa, L., J. Kramář, 1973: Antigenic relationship among several limax amoebae isolates assessed with the indirect fluorescent antibody test (IFAT). *Folia parasitol.*, 20: 113 - 118.

Minář, J., J. Kramář, 1980: Faunistic and zoogeography of mosquitoes of Central Europe in view of forest communities. *Acta Musei Reginae hradecensis. Suppl.* 68 - 70.

2) Books

Bartoš, E., J. Kramář, V. Novák, R. Pelíšek, 1950: Zoologie pro střední školy, statě: Členovci, str. 64 - 98 a Ptáci, str. 144 - 178 (Zoology for highschools, parts: Arthropods, pp. 64 - 98 and Birds, pp. 144 - 178). St. pedagogické nakladatelství, Praha.

Hrbáček, J., a spol., 1954: Jak a proč sbírat hmyz, stať Dvojkřídlí, str. 155 - 162 (How and why to collect insects, part: Diptera, pp. 155 - 162). Nakl. ČSAV, Praha.

Jírovec, O., a spol., 1954: Parasitologie pro lékaře, statě: Ekologická parasitologie, str. 18 - 22, Komáři, str. 381 - 403 (Medical Parasitology, parts: Ecological parasitology, pp. 18 - 22 and Mosquitoes, pp. 381 - 403). St. zdrav. nakl., Praha.

Kramář, J., 1955: Komáři rodu Aedes v ČSR (Mosquitoes of the genus Aedes in Czechoslovakia). Rozpravy ČSAV, řada MPV, ročník 65, sešit 9, pp. 67.

K r a m á ř, J., 1957: Parasitologie in der Tschechoslowakei. Nakl. ČSAV, Praha, pp. 21.

K r a m á ř, J., 1958: Komáři bodaví (Biting mosquitoes). Fauna ČSR sv. 13. Nakl. ČSAV, Praha, pp. 283.

J í r o v e c, O., a spol., 1960: Parasitologie für Ärtzte, stať Diptera, str. 573 - 641) (Part Diptera, pp. 573 - 641). VEB Gustav Fischer Verlag, Jena.

J í r o v e c, O., a spol. 1977: Parasitologie pro lékaře, III. přepracované a rozšířené vydání, stať: Imunofluorescenční technika v parasitologii, str. 194 - 199, Diptera, str. 658 - 715 (Medical Parasitology, 3rd Edition, parts: Immunofluorescence techniques in parasitology, pp. 194 - 199 and Diptera, pp. 658 - 715). Avicenum, zdravot. nakl., Praha.

K r a m á ř, J., J. M i n á ř, 1971: Klíč zvířeny ČSR, díl V., statě Chaoborinae a Culicinae, str. 63, 64 - 68 (Key to the fauna of Czechoslovakia, Vol. 5, parts: Chaoborinae and Culicinae, pp. 63, 64 - 68). Nakl. ČSAV, Praha.

R o z k o š n ý, R., a spol., 1980: Klíč larev vodního hmyzu, stať Culicidae (Minář, J., Kramář, J.), str. 282 - 298 (Key to the larvae of water insects, part Culicidae (Minář, J. and Kramář, J.), pp. 282 - 298). Nakl. ČSAV, Praha

Professor Kramář wrote a number of articles fot the journal „Natural sciences in schools" where he made the teachers' public aware of the importance of parasitic diseases and of parasites.

Ž. Černá

G e o r g e A. and Anthony B. B u b e n i k (Editors): *Horns, Pronghorns and Antlers - Evolution Morphology, Physiology and Social significance.* 562 pp, 204 illustrations, Springer-Verlag, New York, Berlin Heidelberg, London, Paris, Tokyo, Hong Kong.

Antlers and horns have been attracting the attection of man since primeval times. Special significance has been attributed to them in culture, medicine and religion throughout human history. On the other hand, these strange, remarkable morphological structures have had and extremely important part in the evolution of mammals. Conspicuous is the diversity of shapes and sizes of horns and antlers whose true significance and the rules of their development and formation were a mystery for a long time. From the biological point of view, neither horns nor antlers received the attention that was due to them considering their evolutionary and social importance. One of the editors of this book, the Czech biologist Dr A. B Bubenik has devoted practically all his life to research on the evolution and physiology of antlers and horns and, moreover, he has been fortunate in finding an equally enthusiastic colleague in his son who has added much to his pioneer work. I should like to point this out before assessing this unique book. The editors have not confined themselves to their own results and rich experience, and invited seventeen other leading specialists to collaborate on the fundamental monograph.

The book is divided into two parts; the first deals with the morphology of horns and antlers, their evolution and the physiology of antler and pronghorn cycles. The described ethological experiments are extremely interesting by their originality and by revealing important sociological aspects of the cervid life. The relation of reproductive and feeding strategies to the evolution of horns and antlers is examined in this connection. This subchapter also includes the taxonomy and descriptions of morphological characters of the families of horned and antlered ruminants: Muntiacidae, Cervidae, Giraffidae and Bovidae.

Physiological, ontogenetic, genetic and sociological questions are treated in detail in the second part consisting of 13 chapters. The first in about the unique American species *Antilocapra americana*, its phylogenetic relationships to the other ruminants, and its pronghorns which are unique among recent ruminants and whose development is unique too. Principal chapters are those on the nervous and humoral regulation of the antler cycle. In addition to providing basic data, these chapters contain important surveys of experimental methods concerning handling, induction of the growth of antlers, their regeneration and the embryonic development of centres. Naturally, the growth of antlers is discussed in relation to the reproductive cycle and thus to external environmental factors, and there is also a chapter on the influence of food and nutrition on the development of antlers. Very important is a chapter on the genetic variability of antler development, and another examining the role of these morphological characters, involving social hierarchy, in the cervid social life.

Owing to the high level of treatment of the subject and the extensive bibliography the book has all the features of a groundwork for further systematic research on the evolution, physiology and sociology of horns and antlers. I recommend it to all students of these questions, as they will find in it a summary of our present knowledge as well as many stimuli for further investigations, among others into the possibility of using antlers and their cycle in biomedical research. The editors and Springer publishers certainly deserve our thanks for a substantial contribution to zoological and biological literature.

Z. Veselovský

S c h m i d t , G. D., R o b e r t s , L. S.: *Foundations of parasitology.* Fourth Edition. St. Louis, Toronto, Los Altos, Times Mirror/Mosby College Publishing 1989. 750 pp. Price 51.00 USD.

As explained in its preface, in preparing this book the authors have exploited countless of facts from hundreds of journals, reviews and books. The contents of the publication consists of 41 chapters. Chapters 1 - 3 are concerned with principal definitions. Parasitic organisms are classified according to schemes of zoological systems. Chapters 4 - 21 provide information on parasitic protozoans. Biological properties are characterized together with an overview of the classification of phyla of protozoans in orders or suborders,

according to the scheme of L e v i n e et al. (1980). Chapter 12 informs about parasitic animals of phylum Mesozoa. Chapters 13 - 33 give an outline of parasitic worms (helminths). The authors propose their own modification of classification scheme, which they consider to be practical and universally understandable. Chapters 34 - 41 deal with the phylum Arthropoda (sometimes subphylum). In the class of Insects, the classification scheme of pterygotes is given according to R i c h a r d s and D a v i e s (1977) and arachnids according to S a v o r y (1977). The conclusion is comprised of a glossary of terms from parasitology and bordering fields (pathology, immunology).

This comprehensive publication, matured in four successful editions, ranks among the foremost [illegible]zed manuals of parasitology. It includes besides medical and veterinary aspects also biological ones. The innovation concerned not only new piece of knowledge, but also the illustrations. Photographs document not only parasites and their intermediary hosts, but also ecological views, histological sections and pathological changes, stereoscans, etc. Eight full-page colour tables are devoted to malarial plasmodia. Each chapter is concluded by an exhaustive review of references, sometimes listing over 100 quotations. The amount of information brought in by the two authors usually requires dozens of collaborators in publications of similar extent. The book represents an outstanding aid for undergraduate and postgraduate students in medical, veterinary and biological courses.

J. [illegible]

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